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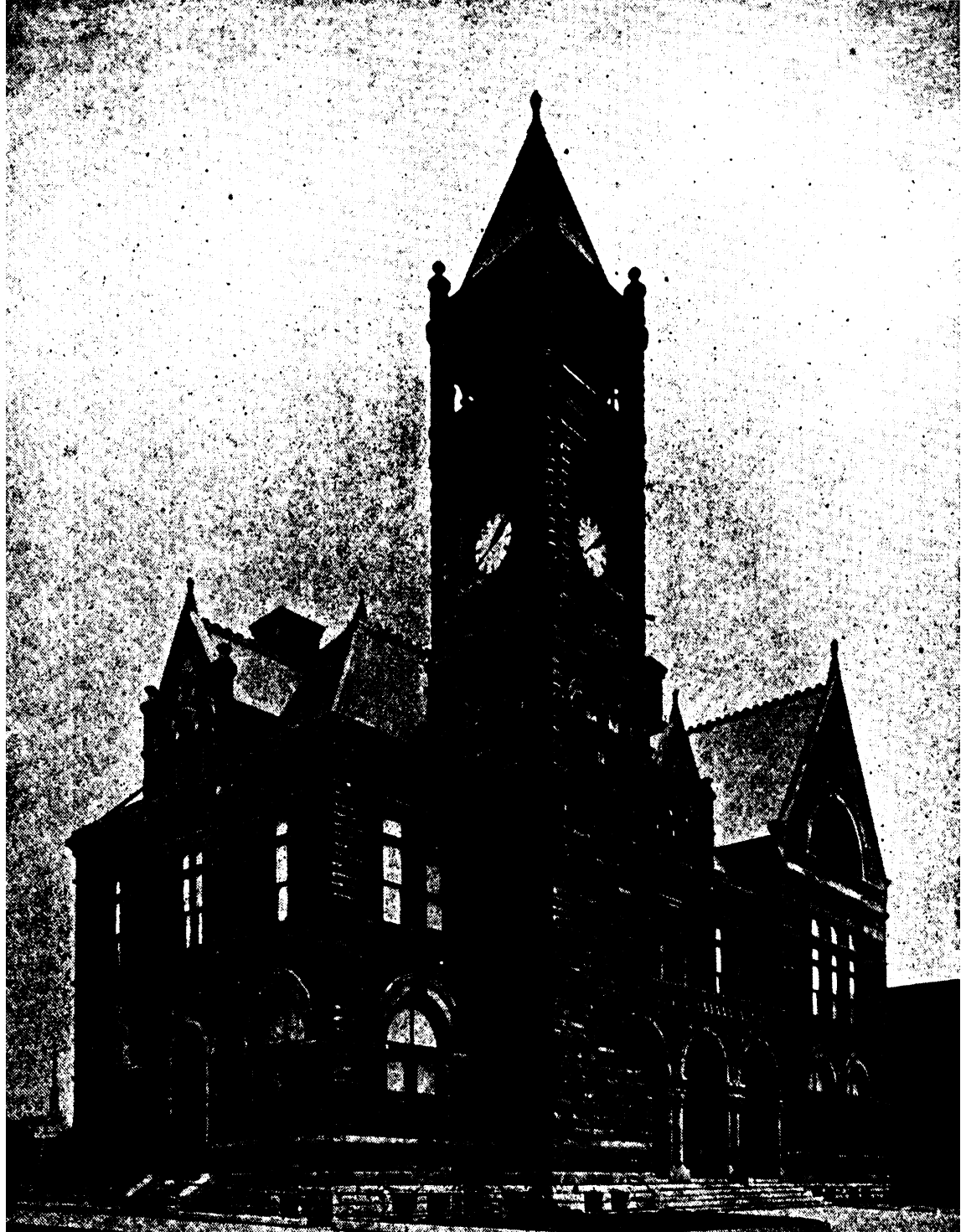
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*Biennial report
of the State Geologist*

J. D. WHITNEY.

HARVARD UNIVERSITY.



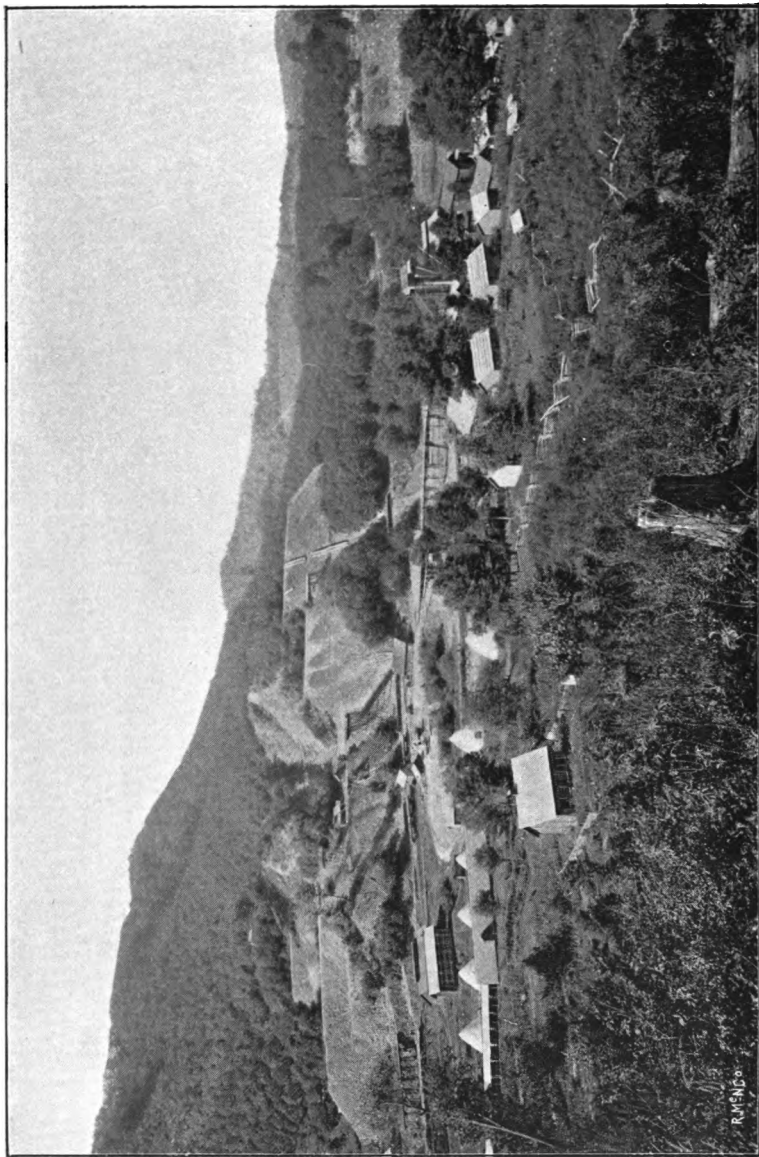
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THE CRANBERRY IRON MINE.

NORTH CAROLINA GEOLOGICAL SURVEY.

J. A. HOLMES, STATE GEOLOGIST.

FIRST BIENNIAL REPORT

OF THE

Compliments of

J. A. Holmes,

State Geologist.

RALEIGH:

JOSEPHUS DANIELS, STATE PRINTER AND BINDER.

1893.

2

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J. A. HOLMES,	State Geologist.
H. B. C. NITZE, Assistant Geologist,	Iron ores.
J. V. LEWIS, Assistant,	Building materials.
W. W. ASHE, Assistant,	Forestry.
W. L. SPOON, Assistant,	Diamond drill borings.
H. L. HARRIS,	Sec'y and Gen'l Assistant.

LETTER OF TRANSMITTAL.

NORTH CAROLINA GEOLOGICAL SURVEY,
RALEIGH, N. C., January 1, 1893.

To his Excellency, GOVERNOR THOS. M. HOLT:

SIR:—I have the honor to submit herewith the first biennial report of the existing Geological Survey of North Carolina. It embraces, in addition to the administrative statement, an outline of the results of the work done during the years 1891 and 1892 in relation to iron ores and building stone.

The more extended statements of the results of the work will be published in special reports or bulletins as rapidly as these can be prepared.

In view of the fact that the mineral resources of the western counties of the State were at the time attracting more attention, and that they were the only ones of which topographical maps existed, the field work of the survey was begun in these counties. In this region, however, the geological structure, which had never been carefully examined, was found to be exceedingly complex, and this fact and the many difficulties encountered in the beginning of a work of this kind have combined to retard the progress made and limit the results accomplished by the Survey.

The benefits resulting from the work of a Geological Survey are never fully realized until years after the work has been completed and the reports published; but it is encouraging to note that even thus early in its history the present Survey has been instrumental in bringing to the State returns many times greater than its cost.

I beg, in conclusion, to express my appreciation of the active interest you have always shown in the work of the Survey and the wise counsel you have contributed to its management.

With great respect I have the honor to be, sir,

Yours obediently,

J. A. HOLMES,
State Geologist.

FIRST BIENNIAL REPORT OF THE NORTH CAROLINA GEOLOGICAL SURVEY.

BY J. A. HOLMES, STATE GEOLOGIST.

INTRODUCTORY.

The existing Geological Survey of North Carolina was authorized by an act of the General Assembly of 1891. The writer received his commission as State Geologist on May 1st of that year; and the field work of the Survey began in June following in the north-western counties of the State. In view of the complexity of the geological structure in western North Carolina and the difficulties attending the inauguration of a work of this character, it will be readily understood that in the beginning progress was necessarily slow, and no elaborate reports can yet be prepared. The present report is not intended to include more than a general administrative statement, to which is added a summary of the results of the work of the Survey in relation to iron ores and building stone. It will be followed by other special reports or bulletins which will embody fuller statements of these results and which will be published from time to time as the *data* for them accumulates.

OBJECTS AND ORGANIZATION OF THE SURVEY.

The object for which the Survey was established, as expressed in the authorizing act, is "the thorough examination of the nature and extent of the mineral and timber resources of the State." The accomplishment of this object has been kept steadily in view in the organization and in all of the plans for the work of the Survey.

After a careful consideration of the work accomplished by preceding Geological Surveys in the State—under Emmons and Kerr—

the results from both of these having been lost in large measure by not having been published, it was found that a considerable amount of general exploration would be necessary in many portions of the State before undertaking, or in connection with, the examinations of special mineral deposits. And during the past two years a considerable portion of the time has been devoted to such *reconnaissance* work and preliminary investigations.

In connection with and in addition to this general work the following special subjects have been investigated by different persons connected with the Survey:

Iron ores, by H. B. C. Nitze.

Building materials, by J. A. Holmes and J. V. Lewis.

Geology of the coastal plain region, by J. A. Holmes.

Forests and forest products, by W. W. Ashe.

General mineral resources, by S. L. Penfield and others.

Coal and marble, diamond-drill borings, by W. L. Spoon.

INVESTIGATION OF IRON ORES.

The investigation of the iron ore deposits in the State was assigned to Mr. H. B. C. Nitze, a graduate of the mining school at Lehigh University, who has had a considerable amount of experience in the examination of iron deposits in several adjacent States. Mr. Nitze was appointed Assistant Geologist in June, 1891, and at once began an examination of the iron ore deposits of Ashe, Alleghany and Watauga counties, and remained in these counties during the remainder of the field season of that year. During the summer months he was assisted by Mr. H. L. Harris.

During the field season of 1892 he examined the more important iron deposits in all the other counties of the State where such deposits occur, extending his investigations over a territory of some 6,000 square miles in area, distributed through twenty-three counties.

During this examination some valuable iron ore deposits were discovered, and a number of other deposits were shown to have a value considerably greater than was formerly supposed.

At the end of this report will be found a statement by Mr. Nitze, embodying the more important results of his work during

the years 1891-1892. A more elaborate statement is also to be published in the form of a separate bulletin (No. 1).

INVESTIGATION OF BUILDING STONE.

The investigation of the building stone deposits in the State was begun by the writer as soon as the Survey was organized, and has been continued by him at intervals until the present date. Mr. J. V. Lewis, a graduate of the University of North Carolina, and an assistant in the United States Geological Survey in 1891, was, in October of that year, appointed on the State Survey as an assistant in the building stone investigation, and continued in this position until October, 1892, when he was granted a leave of absence. During these two years (1891 and 1892) a preliminary examination of the building stone deposits was made in thirty counties, lying mainly in the midland and piedmont regions, but including Craven county in the east and Cherokee and Buncombe of the extreme west.

Many analyses and tests of the physical characters of the building stone of different regions have yet to be made before a more extended report on this subject can be published. But it is expected that a bulletin, embodying the results obtained up to date, will be published in the near future. The statement to be found further on in the present report, prepared mainly by Mr. Lewis, contains a *resume* of the results thus far obtained of the field exploration.

GEOLOGIC WORK IN THE COASTAL PLAIN REGION.

The eastern counties of the State grouped together occupy the territory here designated as the Coastal Plain region. This region has an area of about twenty thousand square miles, lying east of an irregular line from Gaston by way of Raleigh to Wadesboro. The geological formations of this region, consisting mainly of horizontally bedded and unconsolidated sands, clays, loams and marls, are radically different both in character and in age from those found in the middle and western counties of the State, which are composed mainly of highly crystalline, folded, diked, faulted and eroded schists, gneisses and granite. (See plate VII).

The examination of this region has been carried on during the past two years by the State Geologist at such times as could be spared from the work in the office and other investigations in the western and middle counties. The objects of this investigation have been the examination into the history and the character of the geologic formations; the occurrence in them of economic materials, such as phosphate, limestones and marls, and of deep lying water-bearing sands and gravels; and the origin and character of the soils, together with an examination of the character and distribution of the forest growth on these soils in different portions of the region.

In the prosecution of these investigations trips have been made down each of the principal rivers in small boats, so that the formations could be examined in the bluffs exposed along the line of the rivers; and at intervals overland trips have been made either on foot or on horseback across the country between the rivers. The examinations of the forests will be carried on more especially by Mr. W. W. Ashe, who will make extended trips on horseback through the different portions of the several counties of this region.

The general results of these investigations in the coastal plain region will be published in a special report at an early date; and the result of the forest investigations will be published in a Survey bulletin to be prepared by Mr. Ashe. Among the general results of the work which may be stated at this time are the finding of limited deposits of phosphate and more extensive deposits of limestone in several of the south-eastern counties; the finding of layers of water-bearing gravel and sand which are sufficiently deep below the surface to be free from a contamination of surface waters, and which consequently may be safely tapped by deep borings for a supply of drinking water in many portions of these eastern counties.

In examining the soils of these sandy regions we have found that many of these soils where the "waste lands" are rapidly increasing in area, owing to the cutting and burning off of the forests, are well adapted to the cultivation of various fruits, and may for this purpose be found to yield satisfactory returns for the labor which may be bestowed upon them. We

have also found that in this sand-hill country, where already the "waste lands" amount to half a million acres, over considerable portions of this area there remain a sufficient number of long-leaf pines the seeds from which would be sufficient to restock these regions with young pine trees of this species if the areas could be protected from the ravages of forest fires and hogs.

SUPPLIES OF DRINKING WATER IN EASTERN COUNTIES.

The supplies of good drinking water in many portions of this eastern region is a matter of great importance to every person living in the region, and to this subject will be devoted one of the special bulletins of the Survey to be published in the near future. Indeed, this is an important problem for all sections of the State, whether thickly or sparsely populated. A large majority of our people use as drinking water that which comes from springs or shallow wells; and under favorable conditions water derived from these sources may be considered fairly safe for drinking purposes; but it should always be borne in mind that water from both these sources is, as a rule, of surface origin, and generally that it falls as rain water in the vicinity of the spring or well, soaks downward through the surface soil, carrying with it more or less of the impurities of the soil, and either comes to the surface again at some lower point as spring water or soaks into the sides of wells dug or bored to varying depths in the soil.

Considered in this light it will be readily understood that impurities of various kinds may reach the water which we drink not only by being washed into the open top of a well from the surface, or into a spring, but that they may soak down through the porous soil at a considerable distance from either spring or well, and yet permeate the drinking water by soaking through the soil of the immediate vicinity. And while these facts apply to all portions of the State they are especially applicable to these eastern counties of the coastal plain region. Here the drainage of the entire surface is less perfect than in the hill country, and stagnant surface water is far more abundant. The constant supplies of water are nearer to the surface, and at the same time, as the soils are more porous, the rain water soaks into them and down through the upper layers more rapidly and more abundantly than is the case in the hill coun-

try. And the result of these conditions is that waste matters which may lie on the surface soil in the fields or about the houses, and the germs which may accompany the decay of organic matter at the surface, may be carried down occasionally through the upper layers of the porous soil into the springs and wells which furnish the supplies of drinking water for this region.

From the result of inquiries now being made by the active Secretary of the State Board of Health, as well as those made by the writer, it is evident that this surface contamination of the drinking waters is probably the greatest source of the malaria prevailing in these counties; and it matters not whether the wells in this region be large open wells or the small bored wells; the impurities from the surface may soak down through the soil into the one almost as easily as into the other, because these impurities reach the water not so much by being washed into the open top but by soaking down into the sand and gravel which are the sources of the water supply.

It is for this reason that the Geological Survey has undertaken to investigate the possibility of supplies of drinking water at depths below the surface sufficient to be beyond the reach of such local surface contaminations. And it has found that in many if not in all portions of this region while the surface soils are usually loose and porous and below them, at depths varying from 10 to 30 feet, occur the water-bearing gravels, below these gravels occur the clay and the marls, and below the clay and the marls, at depths varying from 50 to 300 feet or more from the surface, there are other layers of sand and gravel which furnish ample supplies of water. And this water when it can be obtained should be fairly free from injurious matters because of the fact that the intervening clays prevent the surface water of the immediate vicinity from passing down into these lower layers of sand and gravel. In some cases, as shown by the borings at Franklin, Va., in Hyde county, and at Wilmington, in North Carolina, this deep supply of water when tapped by a pipe will rise to the surface of its own accord; and in other cases it comes sufficiently near the surface to be reached by pumps.

EXAMINATION OF THE FORESTS AND FOREST PRODUCTS.

In accordance with the requirement of the law establishing the Survey that it should investigate the timber as well as the mineral

resources of the State, Mr. W. W. Ashe, who is a graduate of the University of North Carolina and of Cornell University, was appointed an assistant in charge of the timber investigations by the Survey in June, 1891. Portions of that year and 1892 he devoted to an examination of the character and distribution of the forests of the counties west of the Blue Ridge, and during the latter part of 1892 he began an examination of the forests of the middle and eastern counties, in connection with the collection of timber exhibits for the Columbian Exposition.

A report embodying the result of his examinations in the eastern counties will be ready for publication at an early date, and he will subsequently prepare for publication reports on the forests of the middle and western counties. A report including a description of the characteristics and the distribution of the more valuable forest trees of the State will also soon be prepared for publication by Mr. Gifford Pinchot, whose studies in forest management have been carried on in different parts of Europe as well as in the United States, and whose practical work in forestry has been carried on largely in western North Carolina. Mr. Pinchot is preparing this report without charge for his services. It will no doubt be a valuable contribution to the literature on the subject.

The timber resources of North Carolina are now attracting a large amount of attention from capitalists in all portions of the country, and during the next few years large investments in forest lands will no doubt be made in the State, both in the western and in the eastern counties. Hence, it is important that these reports should be published so that not only capitalists outside may know something of the forest wealth of the State, but also that those who now own these forest lands may know something of their value and the importance of their being treated in such a way that in using the valuable timber now existing on them the young growth may be preserved in such a way as to prevent a destruction of the future forests while using those of the present. And in this connection it may be stated that it will be the policy of the Survey to publish from time to time in the future special bulletins on the management and preservation of the forests of the State, in order that the people who own these forests may be able while disposing of their

supplies of timber now available to do so under such conditions as will best protect the young trees and shrubs from injury by the lumbermen and from the still more common and destructive injuries from the forest fires and stock ; and thus perpetuate the forest wealth of the State.

INVESTIGATION OF THE GENERAL MINERAL RESOURCES.

It is a generally acknowledged fact that North Carolina contains a large variety of minerals, many of which have an economic value. Desiring to secure a wider dissemination of facts concerning these minerals, soon after the organization of the State Survey a report on the character and distribution of the minerals in North Carolina was prepared for the Survey by Dr. F. A. Genth, who did this work without remuneration from the State, and this report has been published by the United States Geological Survey as Bulletin 74 of its series. Thus, without cost to the State, a large amount of information concerning its mineral resources has been published and widely disseminated. During the summer of 1892, Professor S. L. Penfield and Mr. Joseph H. Pratt, of the Sheffield Scientific School, Yale University, without remuneration for their services, investigated a large number of mineral deposits in the counties west of the Blue Ridge, especially in the mica mines of Yancey and Mitchell, and the chrysolite rocks and the associated chrome and corundum deposits in Watauga, Mitchell, Yancey, Jackson, Macon and Clay counties; and the results of these investigations will be embodied in a future bulletin to be published by the Survey.

COAL AND MARBLE INVESTIGATIONS WITH THE DIAMOND DRILL.

Early in 1891 the coal deposits near Walnut Cove, Stokes county, were attracting considerable attention, and it was considered advisable to investigate them. As this could not be satisfactorily done in any other way, the Survey rented a diamond drill from the Pennsylvania Diamond Drill Company, and placed the work under the supervision of Mr. W. L. Spoon, in July of that year, and the work was continued until May, 1892. Two holes were bored in this field, the deeper one going down about 1,112 feet, and no valua-

ble bed of coal having been penetrated, the work was abandoned. This negative result does not necessarily indicate the absence of valuable deposits of coal from the entire Dan river sandstone belt, but it does indicate their absence in the particular rocks penetrated by these borings. And while the result in this case is a negative one and led to no additional investments of capital, it prevented the expenditure of considerable sums of money which would have been lost in proposed mining operations.

Near the south-western end of this sandstone belt, between Walnut Cove and Germantown, the indications of the existence of workable beds of coal are more favorable than those in other portions of the region, and here they are worthy of further investigations, but in the immediate vicinity of Walnut Cove, where the borings were made, I think the negative evidence may be accepted as final.

Early in the summer of 1892 the drill outfit was transferred to Turkey Cove, McDowell county, and used in the exploration of the marble deposits which were found there, and the work was continued there under the supervision of Mr. Spoon. Four holes were bored into these deposits, 296; 101; 253, and 94 feet in depth, respectively; the holes being located in such positions as to indicate a total thickness of more than a thousand feet of marble. The general results of this investigation showed that, while a considerable portion of the stone, on account of its fractured condition, would be unsuitable for architectural purposes, there are considerable masses of it which will be found satisfactory for such uses, and the larger part of the fractured stone might be used in the making of lime.

THE WORK OF THE STATE GEOLOGIST.

In addition to the work in connection with the examination of the building stone and the geology of the eastern counties the State Geologist has co-operated with the persons engaged in all the work described above, and in addition to that he has attended to the large correspondence of the Survey and the general office work; thus, as far as possible, giving his personal attention to all of the details connected with the work.

The correspondence of the Survey since its inauguration has required the answering of about 3,000 letters, many of which

necessitated a considerable expenditure of time and energy, either in the examination of mineral specimens or the bringing together of information concerning mineral and timber resources.

The keeping of accounts in connection with the disbursements of the funds of the Survey has also added considerably to the work done by the State Geologist, and the editorial work necessary in preparing for publication the reports now approaching completion is adding still further to the demands on his time. In the future the amount of this editorial work connected with the preparation and publication of the reports of the Survey will be considerably increased; and this will require the turning over of much of the office-work to a regular assistant employed for this purpose.

MISCELLANEOUS WORK.

In addition to the regular work of the Survey as outlined above a limited amount of work was done in several additional directions, the following being the most important:

TOPOGRAPHY.—During the months of October and November, 1891, Mr. Hersey Monroe was assigned by the United States Geological Survey to work in North Carolina, and during that time he revised the topographic atlas sheet covering the important iron ore regions of Ashe and Alleghany counties. During the entire field season of 1892 Mr. Monroe was again assigned to work in North Carolina and revised the Cranberry atlas sheet, which includes Watauga and parts of adjacent counties. Mr. C. E. Cook was assigned by the United States Geological Survey to work in revising the topography of the Murphy atlas sheet covering portions of Cherokee county.

PHOTOGRAPHY.—During the two years (1891 and 1892) several hundred photographs were taken by the Survey of the forests, mineral properties, and landscape scenery of the State. Many of these are to be used for illustrations in the reports, but the larger part of them were taken with a view to their exhibition as a part of the North Carolina exhibit at the Columbian Exposition, Chicago. Quite a number of these photographs are being copied, without expense to the State, and these copies will be widely distributed through many of the Northern and Western States, and will doubtless be the

means of interesting a considerable number of people in the resources of this State.

COLLECTIONS FOR THE COLUMBIAN EXPOSITION.—During 1892 while engaged in the general work of the season each member of the Survey staff collected for the North Carolina exhibit at the Columbian Exposition such specimens of building stone, ores, minerals and timbers as could be secured without too great a loss of time. And under the direction of the Board of World's Fair Managers, and at their expense, Mr. Nitze went to Chicago, and gave about one month's time in the spring of 1893 to the arrangement of the North Carolina mineral exhibit at the World's Fair.

CO-OPERATION FROM THE UNITED STATES GEOLOGICAL SURVEY.

During the past two years the United States Geological Survey has co-operated with the State Survey on a liberal scale, mainly along the line of the topographic work already mentioned. In addition to the work of Messrs. Monroe and Cook alluded to above another topographic party was at work during 1891 and 1892 in the piedmont counties. This topographic work must be done in advance of the geologic work, and hence the preparation of such a map as that which is being made will prove of great value to North Carolina. Already over 12,000 square miles have been surveyed and mapped—nearly one-fourth of the total area of the State. This work has cost to date more than \$50,000, the entire amount being paid by the United States Geological Survey.

In addition to the topographic work Mr. Arthur Keith, of the United States Geological Survey, was assigned to geologic work in Cherokee county during the latter part of 1892. And valuable assistance was rendered the State Survey in the spring of 1892 by Professor C. R. Van Hise, Professor R. Pumpelly and Mr. Baily Willis, and in the summer of that year by Professor George H. Williams—all of the United States Geological Survey.

CHEMICAL ANALYSES AND ASSAY WORK.

Arrangements have been made for the analysis or assay of all samples collected by persons connected with the Survey in the prosecution of its regular work, and a considerable number of such

analyses have been made already. But it will be apparent to all thoughtful persons that the Survey cannot undertake to make analyses of miscellaneous samples of minerals, ores and waters, collected by other parties, either gratuitously or for a consideration, and for the following reasons:

(1). The making of such analyses would necessitate the employment of one or more extra chemists for this purpose; and each analysis would cost the Survey nearly or quite as much as it would cost the sender to have it made elsewhere, while the sender alone would be benefited thereby; and the benefits to him would be of doubtful value for the reason that,—

(2). Miscellaneous specimens sent in by outside parties are not usually collected in such a way as to secure an average sample, and hence an analysis of it usually indicates very little as to the value of the mineral deposit. Often the samples sent in have been picked up on the surface soil and hence do not represent any known deposit whatever. And hence while the analyses of such samples would be a heavy expense to the Survey they would be of real service neither to the Survey nor to the person sending them.

(3). The analysis of samples collected by persons employed on the Survey requires the full time of the chemist.

SAMPLES SENT TO THE SURVEY FOR EXAMINATION.

While the State Geologist cannot undertake the making of costly chemical analyses of miscellaneous specimens of rocks, minerals and soils for the reasons stated above, he will always be ready to examine free of charge samples of ores or minerals for citizens of the State, and give an opinion as to the probable value of the sample, and where an elaborate chemical analysis or assay is found to be necessary he will be glad to advise with parties sending the samples as to how and where such analyses can be made, and the approximate cost of the same.

The following suggestions are made for the guidance of citizens of the State desiring to send such samples for examination:

1. Each sample should be accompanied by a statement placed inside the package, as to the exact location where found, name of

the sender, name of the owner of the land on which it was found; whether the sample was found as a loose fragment or broken from some large mass of similar mineral.

2. Each package should be addressed to the *State Geologist, Raleigh, N. C.*, and the name of the sender should be written plainly on the outside of the package.

3. Specimens may be sent by mail, express or freight. In either case the transportation charge should be fully prepaid.

4. The State Geologist cannot be held responsible for the loss of samples *en route* for his office or returning to the sender.

RELATIONS OF THE SURVEY TO PRIVATE INVESTMENT.

In order that the relation of persons connected with the Survey to private work or investments in mineral properties may be clearly understood, the following rules were adopted at the commencement of the work:

1. No person in the employ of the Survey will be permitted to acquire a personal interest in any mineral property in the State which has been or is to be examined and reported on by the Survey.

2. The discovery of valuable mineral deposits on the lands of any citizen of the State shall be made known to the owner of such lands before the information has been given to other parties or to the public.

EXPENSES OF THE GEOLOGICAL SURVEY.

The appropriation for the work of the Geological Survey is \$10,000 per annum. Vouchers are collected for all moneys paid out on the Survey account, and monthly itemized certified statements of all such expenditures, with accompanying vouchers, are deposited with the State Auditor after having been examined and approved by the Geological Board. The following statement of the expenses for the two years ending November 30, 1892, showing the objects for which the amounts were paid, has been made up from these vouchers for 1891 and 1892:

Expenses of the Geological Survey for the Two Years Ending November 30, 1892.

Iron ore investigations.....	\$ 3,686 42
Coal investigations.....	957 18
Forestry investigations.....	431 17
Mineral exploration	2,669 88
Building stone investigation	1,303 53
Chemical work and materials.....	1,481 08
Photographic work and materials.....	656 59
Topography	122 63
Clerical assistance.....	423 51
Instruments.....	176 99
Equipment and repairs*	2,368 67
Stationery and printing.....	112 05
Books	92 55
Salary of State Geologist (two years)	4,354 12
Expenses of Geological Board meetings	67 15
Diamond drill explorations for coal and marble.....	1,020 45
Miscellaneous.....	76 03
Total	\$20,000 00

THE FUTURE WORK OF THE SURVEY.

The work of the Survey during 1893 and 1894 will be pushed more rapidly and will include a wider range of subjects than that of the past two years, as shown by the following list of subjects the investigation of which is now being begun. The list also includes some of the subjects the investigation of which was begun during the past two years but which has not been completed. The list is as follows:

1. The iron ores.
2. The building and ornamental stones.
3. The clays and kaolins.
4. The corundum deposits of the south-western counties.
5. The monazite deposits of Clay, Rutherford, McDowell, and Burke counties.
6. The gold deposits of the piedmont and middle counties.
7. The timber resources of the State.
8. The protection of our forests against fires and other destructive agencies.

*This expenditure for equipment is much larger for these two years than it will be in the future, on account of the necessary outlay for tents, wagons, horses, office furniture, etc., in the beginning of the Survey work.

9. The water powers and their development.
10. The mineral waters and other drinking water supplies.
11. The road materials and construction.
12. The lime and phosphate deposits in south-eastern counties.
13. The geologic formations and the resulting soil products.

SOME BENEFITS RESULTING FROM THIS WORK.

These subjects mentioned above reach every section of the State and every class of people; so that the benefits of the Survey, both direct and indirect, are becoming more widely disseminated. Among these benefits it may be said that the Survey has already been largely instrumental in bringing into the State not less than a million dollars of investments in mineral, timber and water-power resources; and the prospects are that these investments will be considerably increased during the next few years.

This, however, is but a partial estimate of the benefits to be derived by the people of the State from work of this kind by the Geological Survey. It serves to educate them up to an appreciation of the natural resources that surround them, and enables them to join intelligently in the development of these resources of all kinds, and thus to build up diversified industries; and thereby increases the material wealth of the community. Furthermore by advising against mining operations in cases where they would undoubtedly result in failure, the Geological Survey prevents the useless expenditure of considerable amounts of money by citizens of the State.

IRON ORES OF NORTH CAROLINA,

BY

H. B. C. NITZE.

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IRON ORE DEPOSITS IN NORTH CAROLINA.

BY H. B. C. NITZE.

INTRODUCTORY STATEMENT.

A fuller statement of the results of the work done on the iron ores of the State will be published in Bulletin No. 1, entitled "Iron Ores of North Carolina." As stated in the preface of that bulletin, the subject-matter was derived from personal investigation in the field during the seasons of 1891 and 1892, beginning in June, 1891. During this time all of the most important iron ore deposits in the State were visited and as detailed an examination given them as the scope of the work and the purposes of a preliminary report would justify. Particular attention was paid to the region west of the Blue Ridge mountains, because of the advantage offered by the topographic maps of the United States Geological Survey, which have been completed for this portion of the State.

The total area examined in different portions of the State amounts to some 6,000 square miles, distributed over twenty-three counties.

This report deals with descriptions of the localities, the extent and character of the ore deposits, as far as possible, and the quality of the ores as determined by analyses. A map of the State, showing the position of the various iron ore deposits, has been prepared and will accompany Bulletin No. 1. A table of 453 analyses, showing the character and locality of the samples, and the names of the chemists by whom analyzed, will also be appended. Some of these analyses are included in the present statement and are given here the same numbers as they have in Bulletin No. 1.

During the field season of 1893 work on the iron ore deposits and on the general geology of the iron-bearing rocks will be continued along the line of the great Smoky mountains, for the most part in conjunction with Mr. Arthur Keith of the United States Geological Survey.

Some brief, general statements showing the result of the work on the iron ore deposits may be here given, as follows:

The ores of iron are found widely distributed in the State. The magnetites and red hematites are found almost exclusively in the crystalline rocks, which are confined to the midland and western counties. The true bedded deposits of brown hematite occur in the lower Paleozoic rocks in the extreme western part of the State, in Madison county, west of Hot Springs, and in the extreme south-western corner of the State, in Cherokee county. Brown hematite is, however, variously distributed throughout the crystalline rocks, sometimes in important masses; as at Ore Hill in Chatham county, the Ormond mine in Gaston county, etc.

The carbonate ores (blackband, ball ore, etc.) are confined to the coal measures of the Triassic. Siderite also occurs as a gangue mineral in some of the gold ores, as at Silver Valley, and Conrad Hill in Davidson county; but not in sufficient quantity to make it of economic value as an iron ore.

The bog ores are found in isolated patches over the more recent formations of the coastal plain region, in the eastern part of the State.

The chromic iron ores occur in the chrysolite rocks in the western part of the State.

THE STRUCTURE OF THE ORE DEPOSITS.

The magnetites and specular hematites of the crystalline rocks are lenticular deposits, pinching and swelling out in all dimensions. These lenticular or cylindrical bodies vary widely in size, being at times so small as to practically preclude working; again they attain enormous development in length, thickness and depth, as at the Cranberry mine in Mitchell county. The enclosing crystalline rocks are for the most part schists and gneisses, micaceous and hornblende; but granitic, dioritic, diabasitic and even more basic eruptives also occur in this position.

The brown hematites usually occur in irregular pocketed beds. In Madison and Cherokee counties the beds are more regular and quite persistent. They occur surrounded by a stiff pipe clay in the calcareous schist, overlying the limestone and underlying the

quartzite. These lower Paleozoic rocks are considerably metamorphosed, and at times become difficult to distinguish from the more ancient crystalline schists. There are two localities in the State where brown hematite occurs apparently in veins, as far as our present knowledge goes: At Ore Hill, in Chatham county, it occurs in almost vertical dikes, which often intersect each other. On Little mountain, in Gaston county, the ore occurs in a heavy, vertical quartz vein.

The blackband and ball ores of the coal measures occur in regular stratified layers or seams, conformable to the carbonaceous shales and slates.

Red hematite ore occurs similarly inter-stratified in the Triassic sandstone in Chatham and Moore counties.

The bog ores occur as local deposits, usually in swampy or marshy places, or around the mouths of springs from which they have been deposited. They cover comparatively small areas, and are altogether irregular in extent.

SOME IMPORTANT IRON ORE DEPOSITS.

Among the more important deposits in the State are:

1. The brown hematites of Ore Hill, Chatham county.
2. The magnetite ores of Stokes, Surry and Yadkin counties.
3. The magnetite and brown hematite ores of Catawba, Lincoln and Gaston counties.
4. The magnetite ores of Ashe, Mitchell and Madison counties.
5. The brown hematite ores of western Madison and of Cherokee counties.

Some of these are still inaccessible, but with their proper development and proof of the existence of large deposits of good ore, railroad connections will not be long in reaching them.

ORE HILL, CHATHAM COUNTY.

ORE HILL is situated forty miles south-east of Greensboro on the Cape Fear & Yadkin Valley Railway. Its elevation is about 300 feet above the level of Ephraim's creek, and it covers about 340 acres. It is the property of the North Carolina Steel and Iron Company.

The country rock is a quartzose talc-slate, knotted and toughened with much tremolite. The ore is brown hematite, with the exception of one vein near the top and back of the hill, which is red hematite, partly specular. A satisfactory explanation of the geologic structure of these ore deposits cannot at present be given. It will require a special study, aided by more extensive development of the mines. It cannot be said now whether these deposits of brown hematite are dikes, regular contact veins or lodes, or gossans. The fact that analyses of the ore show low percentages of sulphur, even where the water level has been reached, rather excludes the last idea. All present indications point to the existence of the ore bodies in regular veins, between regular walls, dipping at very steep inclinations, and having variable strikes.

There are many openings on the hill, some of which have caved in and partially filled up. The more important of these are indicated on the accompanying map (Plate II). They are here briefly described as follows:

Opening No. 1, 1,400 feet south of the railroad, and 207 feet above the same in elevation. It is a large open cut in the face of which a body of brown hematite from 10 to 20 feet thick is exposed. It has been explored by drifts 200 feet long in a due south direction; on the western side of the cut a smaller ore-body has been explored by a drift 40 feet long in ore.

ANALYSIS OF ORE; OPENING NO. 1, ORE HILL, CHATHAM COUNTY.

	(119)
Silica.....	4.73
Metallic iron.....	47.87
Sulphur.....	0.34
Phosphorus.....	0.069
Phosphorus ratio.....	0.144

Opening No. 2, 400 feet N. 60° W. from No. 1, at an elevation of 284.6 feet above the railroad. This is a shaft 80 feet deep. The thickness of the vein is not known, but it is supposed to be over 5 feet. Near here a vein of soft ore has been prospected by a short drift, showing 6 feet of ore.

The Whim Shaft is 400 feet S. 30° W. from opening No. 2, at an elevation of 307 feet above the railroad. It is 90 feet deep; the strike of the vein is S. 15° E.; the dip is vertical. The thickness

N. C. C.

S. 3
S. 34 E. 103

of the ore varies from 15 inches on the outcrop to $2\frac{1}{2}$ feet at the bottom of the shaft. Two analyses from this locality show:

ANALYSES OF ORE FROM 90-FOOT SHAFT, ORE HILL CHATHAM COUNTY.

	(120)	(121)
Silica.....	1.42.....	3.79
Metallic iron.....	57.26.....	58.67
Lime.....	1.19	
Magnesia.....	0.11.....	
Sulphur.....		0.33
Phosphorus.....		trace
Combined water.....	15.26	

Shaft No. 3 is 240 feet S. 85° W. from the whim shaft, at an elevation of 291.8 feet above the railroad. It is 85 feet deep. It is reported that the ore varies in thickness from $1\frac{1}{2}$ feet on the outcrop to 6 feet at the bottom of the shaft. The wall rock is a talcose schist.

ANALYSIS OF ORE FROM SHAFT NO. 3, ORE HILL.

	(122)
Silica	2.35
Metallic iron.....	47.23
Sulphur.....	0.28
Phosphorus.....	0.139
Phosphorus ratio.....	0.294

The Spring Openings are about 1,500 feet S. 75° W. from opening No. 3, on the western slope of the hill. Some old caved-in workings here show evidences of quite extensive operations in former times. A small pit 10 feet deep has partially exposed a vein of ore here, but has not cut through, nor in any way defined its thickness. The ore is soft, and apparently of very good quality.

Opening No. 4, which is but a small pit, without in any way defining the dimensions of the vein, shows up a compact, purplish-brown ore, with occasional, small, cherty seams. It appears to be lying nearly horizontal, and was penetrated by the pit to a depth of 4 feet; it is supposed to be 8 feet thick.

ANALYSIS OF ORE FROM OPENING NO. 4, ORE HILL.

	(123)
Silica	17.32
Metallic iron.....	42.88
Sulphur.....	0.23
Phosphorus.....	0.106
Phosphorus ratio.....	0.247

Opening No. 5 is a small pit near No. 4, 12 feet deep, cutting a vein 8 feet thick as far as exposed; character of ore similar to No. 4.

ANALYSIS OF ORE FROM OPENING NO. 5, ORE HILL.

	(124)
Silica	5.13
Metallic iron.....	39.17
Sulphur.....	0.18
Phosphorus.....	0.064
Phosphorus ratio.....	0.163

The Tunnel Opening is about 1,800 feet N. 18° E. from the Spring openings, very near the northern boundary line of the Ore Hill property. A tunnel has been driven here in a south-westerly direction, striking the ore-vein on the hanging wall side, but as it has not cut through it the thickness of the vein cannot be determined.

ANALYSIS OF ORE FROM THE TUNNEL OPENING, ORE HILL.

	(125)
Silica	3.71
Metallic iron.....	49.79
Sulphur	0.17
Phosphorus.....	0.038
Phosphorus ratio.....	0.076

Between the Tunnel openings and openings Nos. 4 and 5 are several small openings, on the red hematite vein, which is practically nothing more than a very siliceous ferruginous slate, with occasional small streaks of fairly good specular ore, some analyses of which are appended below; but it does not exist in a sufficient quantity, and is therefore valueless from an economic stand-point.

ANALYSES OF RED HEMATITE FROM ORE HILL, CHATHAM COUNTY.

	(117)	(118)
Silica	24.44	.....
Iron.....	49.00	45.70
Sulphur	0.05	.....
Phosphorus.....	0.037	0.252
Phosphorus ratio	0.07	0.551

Below are given a number of additional analyses, showing the composition of the brown hematite ores from Ore Hill, collected from various sources :

OTHER ANALYSES OF BROWN HEMATITE FROM ORE HILL, CHATHAM COUNTY.

	(126)	(127)	(128)	(129)	(130)	(131)	(132)	(133)	(134)	(135)	(136)	(137)
Silica.....	1.30	.....	6.58	1.86	.....	.....	.....	.....	.....	.....	.....	.....
Metallic iron.....	58.76	42.29	53.20	59.62	56.78	60.90	56.17	40.32	57.69	50.24	56.66	46.57
Alumina.....	2.44	.....	.....	2.24	.....	.....	.....	.....	.....	.....	.....	.....
Sulphur.....	0.270	.....	0.170	.....	0.158	.....	.....	.....	.....	.....	.....	.....
Phosphorus.....	0.400	0.235	0.041	0.224	0.488	0.219	0.430	0.182	0.833	0.822	0.641	0.213
Titanic acid.....	1.070	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Combined water.....	9.54	.....	.....	10.00	.....	.....	.....	.....	.....	.....	.....	.....
Phosphorus ratio.....	0.681	0.556	0.077	0.375	0.859	0.359	0.765	0.451	1.443	1.636	1.131	0.457

Considered from a mineralogic stand-point these ores are hydrated oxides of iron, varying in their percentage contents of combined water, as shown by analyses Nos. 120, 126 and 129, from 9.54 to 15.26 per cent., the former approaching very nearly to the true goethite and the latter to limonite. Practically they are known without special distinction as brown hematites.

Considered from an economical stand-point the foregoing analyses show the ores to range from 39.17 to 60.90 per cent, of metallic iron, and from 0.038 to 0.833 per cent. of phosphorus. The silica is uniformly very low, with the exception of one, namely, analysis No. 123, from opening No. 4, where small grains of quartz occur disseminated in the ore.

It is believed that an average of from 45 to 50 per cent. of metallic iron can be obtained in actual mining.

As far as the phosphorus is concerned the variations are so great that no absolute statements can be made as to the average run of the ores in practice; they will probably approach nearer to from $\frac{2}{10}$ to $\frac{4}{10}$ of one per cent. on an average. Only two analyses out of 19 (Nos. 125 and 128) show a phosphorus ratio under the Bessemer limit; and, while certain isolated masses of Bessemer ore may be found, the deposit, as a whole, cannot be depended on to furnish Bessemer ores.

Considered from all aspects, the ores are of excellent quality, and possess the advantage of being clean, not necessitating washing.

CENTRAL MAGNETITE ORE BELTS.

In the central part of the crystalline area of the State a wide and, generally speaking, persistent belt of magnetic iron ore

extends across the State in a south-westerly direction from Virginia to South Carolina.

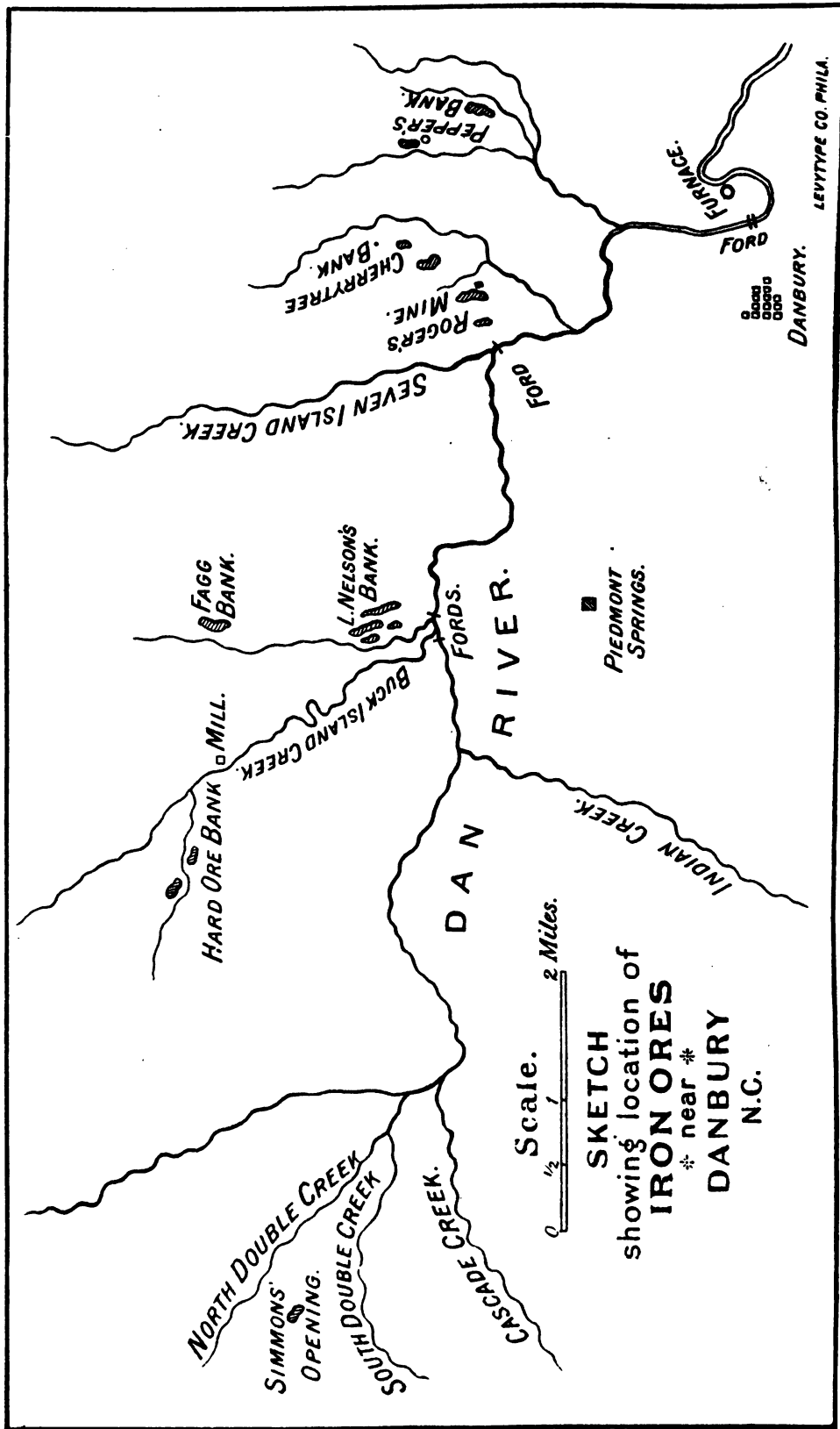
Certain geologic relations are known to exist throughout different parts of this general ore zone, but the study of the structural geology has not at this time proceeded far enough to warrant any definite and entirely comprehensive correlation of the various horizons, except in a general way. And in this connection it is desired again to call attention to the imperative need of a thorough and detailed investigation of the structural and stratigraphic geology of the State, particularly of the crystalline rocks, preliminary to the intelligent study of the economic resources.

The magnetic ores attain their greatest development towards the north-eastern and south-western extremities of this belt, in Stokes, Surry and Yadkin counties, and in Catawba, Lincoln and Gaston counties, respectively.

In their mode of occurrence in talcose, micaceous and silicified schists the ore beds of these widely separated districts bear certain stratigraphic resemblances. The ores of Davie county, on the contrary, are titaniferous, and occur in a hornblendic country rock.

In Catawba, Lincoln and Gaston counties the distinctive stratigraphic relationship is still more strongly marked, and the formation is very persistent, though there is a break in the ore in the southern part of Lincoln and the northern part of Gaston counties, extending over some 12 or 15 miles.

In Stokes county, at the north-eastern extremity of the general belt, the stratigraphic relations, though similar in some respects, are marked by certain distinctive points of difference. As in Catawba, Lincoln and Gaston counties the magnetite ores occur in the talcose, micaceous and silicified schists, and to the north-west a similar zone of micaceous schists, carrying deposits of brown hematite, and coarse granite with mica beds, is found. The manganeseiferous slates also make their appearance to the east of the ore; but the limestone belt here is far on the east instead of the west side of the belt. In general, it appears that the Sauratown mountain range in Stokes county may be closely coincident with that of King's and Crowder's mountains in Gaston county; but as the intimate structure of neither of these localities has ever been prop-



erly studied we are practically in the dark concerning the relations of the ore deposits.

As far back as 1856, Dr. Emmons says:* "At rather distant points the ore of this belt appears in a range so direct that there is no doubt of its passing entirely across the State; it lies parallel with the limestones and slates; there is some doubt respecting the age of the limestone at Germantown; that is, it seems to be different from the King's Mountain limestone." After further consideration he concludes that "there will be no objection to combining the Stokes county and King's Mountain belts."

THE MAGNETITE DEPOSITS OF STOKES COUNTY.

The principal deposits of magnetite ore in Stokes county are situated on the north side of the Dan river. Their locations are indicated on the accompanying sketch map (Plate III).

The ores occur in a series of parallel belts, occupying a width of about $4\frac{1}{2}$ miles, which have been traced in a south-westerly direction for over twenty miles, crossing the Yadkin river into Yadkin county. In a north-easterly direction they continue into Henry county, Va.

Lying to the east of the magnetite ores, a belt of limestone crosses Stokes county in a north-easterly direction from German-town; but it has been found too siliceous to be of a practical value in iron smelting.

The ores of this district may be divided into three classes:

1. Hard ore.
2. Soapstone ore.
3. Sand ore.

This is the vernacular nomenclature, and is meant to be descriptive of the structured characteristics of the ores.

1. The "hard ore" is a hard, compact, massive, crypto-crystalline magnetite.

2. The "soapstone ore" is a soft, greasy mass, composed of crystalline grains of magnetite disseminated through a matrix of talcose and micaceous schists, resembling Lieber's "catawbarite" of South Carolina.

3. The "sand ore" is composed of magnetite grains disseminated through a sandy matrix; it is also soft and friable.

*Geological Report of the Midland Counties, 1856, p. 119—quotation slightly altered.

The "soapstone" and "sand" ores are naturally lower in iron than the "hard" ores; but they may easily be separated from their matrix by the use of the modern improved magnetic separators or concentrators, such as the Edison, Venström, Ball, and Norton, etc.

The strike of the schists varies at all angles between due east and west to due north and south. The direction of the dip varies accordingly between north-west, north, north-east, and south-east; the inclination of the dip is usually between 20 and 40 degrees.

THE WILLIAM NELSON HARD ORE BANK is situated $4\frac{1}{2}$ miles north-west of Danbury. The main opening exposes a body of ore 115 feet long and from 3 to 8 feet thick. It is a steel-gray to black magnetite; though hard and compact it has a decided schistose structure; the gangue is hornblende and chlorite; the hanging wall is a hard, silicified gneiss, and the footwall is hornblende schist. The dip is 20 degrees nearly north.

ANALYSES OF MAGNETITE FROM THE HARD ORE BANK, STOKES COUNTY.

	(340)	(341)	(342)
Silica	21.69	17.83	.....
Metallic iron.....	47.36	53.24	56.04
Sulphur.....	0.018	0.023	.....
Phosphorus.....	0.023	0.052	none.
Titanic acid.....	.....	trace.	.....
Phosphorus ratio.....	0.048	0.097	none.

Not far from here, on the northern slope of School-house ridge, a body of ore 12 feet in thickness is exposed; the hanging wall is mica schist, striking N. 80° E., and dipping 20 degrees north-west.

ANALYSES OF MAGNETITE FROM SCHOOL-HOUSE RIDGE, STOKES COUNTY.

	(343)
Silica	27.80
Metallic iron.....	40.74
Phosphorus	0.121
Sulphur.....	0.09
Phosphorus ratio.....	0.297

THE LEE NELSON ORE BANK is situated about $3\frac{1}{2}$ miles north-west from Danbury. The character of the ore is that of the

“soapstone” class. The thickness of the deposit varies from 3 to 9 feet. The strike of the hornblende gneiss country rock is N. 26° E.; the dip is 20 degrees south-east.

ANALYSES OF SOAPSTONE ORE FROM THE LEE NELSON BANK, STOKES COUNTY.

	(344)	(345)	(346)
Silica.....	20.17	21.47	.....
Metallic iron.....	47.16	47.23	39.70
Magnesia.....	9.53	.....	.....
Sulphur.....	0.007	0.006	.....
Phosphorus.....	0.035	0.081	0.040
Titanic Acid.....	.....	0.190	.....
Phosphorus ratio.....	0.074	0.171	0.101

THE ROGERS MINE is situated 2½ miles north of Danbury. It was probably at one time the largest and best-developed mine in the section. The main shaft was 60 feet in depth, but the workings are now inaccessible. At the bottom of the shaft the ore bed is reported to be 8 feet thick. In other parts of the underground workings it is said to vary from 3 to 15 feet. The wall rock appears to be a blue, silicified and hornblende schist. The inclination of the dip is 21 degrees slightly north of east. The ore is a coarse, granular magnetite in a chloritic and micaceous gangue.

ANALYSES OF MAGNETITE FROM THE ROGERS MINE, STOKES COUNTY.

	(347)	(348)	(348a)
Silica.....	20.00	12.29	11.69
Metallic iron.....	52.86	58.26	63.71
Sulphur.....	0.084	0.179	0.006
Phosphorus.....	0.016	0.001	0.003
Alumina.....	.....	0.580	.....
Lime.....	.....	1.990	0.16
Magnesia.....	.....	3.310	0.17
Phosphorus ratio.....	0.030	0.020	0.050

The following additional analyses of this ore by Dr. Genth are taken from the report on the “Ores of North Carolina,” by W. C. Kerr and G. B. Hanna, published in 1887, p. 172:

ANALYSES OF ORE FROM THE ROGERS MINE, BY F. A. GENTH.

	(349)	(350)	(351)	(352)
Oxides of iron.....	92.47	85.09	79.71	67.66
Oxide of manganese	trace.	trace.	trace.	trace.

ANALYSES—CONTINUED.	(349)	(350)	(351)	(352)
Alumina		0.70	2.27	0.17
Magnesia	0.20	0.16	0.17	0.23
Lime	0.13	0.29	0.31	0.19
Phosphoric acid.....	none.	none.	none.	none.
Actinolite	7.20	13.76	15.66	31.75
Water.....			1.88	
Metallic iron.	65.34	61.74	57.13	49.03

These analyses show very wide variations, due undoubtedly to the varying nature of the ore bed itself. But in what proportion these different grades of ore are distributed in the bed can only be determined by careful examination of the deposit in place, which, until the mine is cleaned out and again developed, is naturally impossible. Dr. Genth has described the ore as being absolutely free from phosphorus, but he probably meant that it was *very low* in phosphorus, so low that it was not considered worth while to determine it. However, the importance of determining even the very smallest per cent. of this element must not be overlooked, for to the iron manufacturer it is always an important factor in estimating the true value of the ore.

Analyses 347, 348 and 348a show its presence, though in very minute quantity, and safely below the Bessemer limit.

THE PEPPER MINE is another of these old, abandoned ore banks. It lies $2\frac{1}{2}$ miles north-east of Danbury and about $1\frac{1}{2}$ miles east of the Rogers mine. The ore is a granular magnetite, disseminated in mica schist, and the old workings were apparently of considerable extent. A tunnel is said to have cut the ore from 6 to 8 feet in thickness.

ANALYSIS OF ORE FROM THE PEPPER BANK, STOKES COUNTY.

	(354)
Metallic iron.....	44.08
Phosphorus	0.033
Phosphorus ratio.....	0.075

THE ISAAC FAGG ORE BANK is situated 4 miles north-west of Danbury, and 1 mile north-east of the Lee Nelson bank. The ore deposit consists of a series of sandy ore seams of variable and irregular thickness—reaching 4 feet at one point. It belongs to

the class called "sand-ore." The cap rock is a decomposed gneiss, dipping about 30 degrees slightly west of north.

ANALYSES OF ORE FROM THE ISAAC FAGG BANK, STOKES COUNTY.

	(355)	(356)
Silica.....	25.47	18.35
Metallic iron	42.48	48.62
Sulphur	0.049	0.021
Phosphorus.....	0.079	0.117
Titanic acid		0.170
Phosphorus ratio.....	0.186	0.240

All prospects point to the existence of large and valuable deposits of magnetic ore in the Danbury region. They lie well for mining, and the numerous creeks and hollows make them easily accessible to the river bank. The nearest railroad point to Danbury is Walnut Cove, $11\frac{1}{2}$ miles south-east, at the junction of the Norfolk & Western and the Cape Fear & Yadkin Valley roads. A branch road has been surveyed along the ridge road from Walnut Cove to the head of Poor-house branch; down the valley of that branch to Flat Shoals creek; with the valley of said creek to the Dan river, and up the river to Danbury; and when this is built there is no reason why these ores should not find a market.

MAGNETITE ORES IN SURRY AND YADKIN COUNTIES.

The ores of Surry and Yadkin counties consist of magnetite grains disseminated in mica schist and gneiss, resembling in that respect some of the Stokes county ores; and their economic value, as far as quantity is concerned, will thus in a great measure be dependent upon the cost of separating these magnetic grains from their gangue by means of magnetic concentration. The rock is usually decomposed to great depths, and is therefore well adapted to easy and cheap crushing, preliminary to concentration. Some of these deposits appear to become pyritous below the water level.

IRON ORES IN GASTON, LINCOLN AND CATAWBA COUNTIES.

The magnetites of Catawba, Lincoln and Gaston counties comprise a belt about 20 miles in length and several miles in width. Their general distribution is indicated on the accompanying out-

line map (Plate IV). The ores occur in the talcose, micaceous and silicified schists of a series of slaty ridges and knolls in Lincoln county, and along the eastern foot-hills of Anderson's mountain in Catawba county, having a general trend of N. 20° E. The beds are nearly vertical and dip sometimes to the east and sometimes to the west, but the westerly dips are by far the most frequent. For a considerable part of the belt in Lincoln county there are two parallel beds, the more westerly being the more productive, and the combined thickness being from 4 (rarely so low as 2) to 12 feet; the interval of 12 to 20 feet between them is occupied by talcose and chloritic schists, with a little ore in layers. The beds generally occur in lenticular masses or flat disks, which thicken at the middle and thin out towards the edges, having the same general dip as the bed; but they do not succeed one another in the same plane; their edges overlapping so as to throw the upper edge of the lower disk behind the lower edge of the upper. The following is an ideal section, illustrating this:

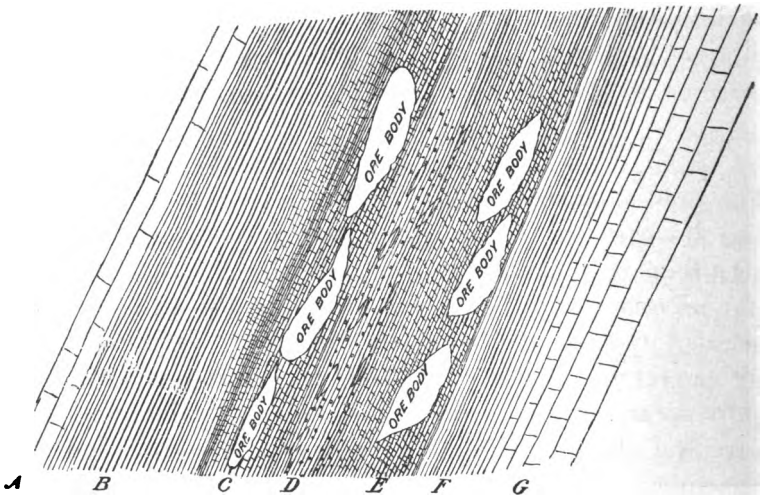


Fig. 1.—Ideal section, showing lenticular structure and position of magnetite ore beds, Lincoln county.

"A, sandstone or quartzite. B, talcose schist (slate). C, 'Front' ore bed of actinolitic, chloritic and somewhat talcose schists, containing ore bodies. D, talcose and chloritic schists, containing small quantities of ore, mostly in grains. E, 'Back' ore bed, for most part similar to C. F, talcose schist. G, gneiss.



"The above-mentioned layers shade into one another; thus the sandstone or quartzite, A, passes into the siliceous talcose schist, B, which in turn graduates into the 'front' vein, C, a mass of actinolitic, chloritic (somewhat talcose) slate, with iron ore in grains or lenticles. The change from the slates into the ore lenticles is frequently obscure, and the lenticles themselves are often schistose in structure. The change into the talcose slates, D, is equally obscure. In this body the ore is in grains, associated with the chloritic matter, or in small lenticles.

"The statements about C apply for the most part to the 'back' vein, E.

"The changes into and from F are as in B, but the mass seems to be less siliceous. The separation of the ore bodies is sometimes very slight, and often they are connected by an almost imperceptible thread of ore which needs the quick eye of the skillful miner to follow. These lenses are sometimes many feet thick, and frequently of great length and depth."

The principal ones of the old ore banks, in their regular succession north-eastward along the strike, were: The Big Ore bank, the Brevard, Stonewall and Robinson banks in Lincoln county; and the Morrison, Tillman, Deep-hollow, Mountain-creek, Abernathy, Littlejohn and Powell banks in Catawba county, the latter two being towards the Catawba river.

THE BIG ORE BANK is situated in Lincoln county, 4 miles north of Iron Station. The ore was last mined in the "Engine shaft," which was 100 feet deep but is now filled up. Three ore bodies, respectively 18, 12 and 8 feet in thickness, were reported. The ore is of two classes. The "gray ore" consists of granular magnetite, disseminated in a micaceous schist, while the so-called "red ore," though really strongly magnetic, has a slight reddish tinge, due to the presence of red oxide (probably martite) in small quantities.

ANALYSES OF MAGNETITE FROM THE BIG ORE BANK, LINCOLN COUNTY.

	(270)	(271)	(272)	(273)
Silica.....	6.19	1.07	9.17	.....
Metallic iron.....	66.92	68.40	58.56	68.12
Alumina.....	.....	.....	2.46	.....

ANALYSES—CONTINUED.	(270)	(271)	(272)	(273)
Lime.....	.....	.....	0.27	.....
Magnesia .....	.....	.....	4.33	.....
Sulphur	0.068	0.069	0.086	0.120
Phosphorus.....	0.082	0.072	0.013	0.006
Titanic acid.....	.....	.....	.....	none.
Phosphorus ratio	0.124	0.105	0.022	0.008

No. 270. Gray ore, sampled from old stock pile at Rehoboth furnace.

No. 271. Red ore, sampled from old dump at mine.

No. 272. From shaft near water level.

No. 273. Red ore.

Not much can be said of the remaining portion of the Lincoln-Catawba part of this belt, for the mines have been deserted and are now inaccessible. This region was at one time the scene of active mining and smelting operations. Its abandonment was due, not to the lack of ore, but to the inaccessibility of the product to a market, and probably in a great measure to the lack of capital and energetic management. However that may be, the field is certainly worthy of a careful, practical investigation, which will require both time and money. The old shafts must be cleaned out, others must be sunk, unopened area must be explored and tested; in short, the ore bodies must be examined in place before an intelligent report of the probable extent and quantity can be made.

The erroneous supposition would be quite liable to occur to many that because these ores have been worked and smelted for so long a period as one hundred years they should be exhausted. This is fallacious; the old forges and furnaces, of small capacity, and working as spasmodically as they did, have not drawn on the ore supply sufficiently to make any material difference. For the most part, indeed, they obtained their ore from the very surface, or mined it in shallow pits along the outcrop, a method appropriately named "ground-hogging." In no instance have the shaft workings—and there are but few of them—extended below the water level. If the ore was ever there it is still there, without any appreciable difference in quantity.

Attention may be called to the possibility of the brown hematite zone running parallel to this belt on the west, affording sufficient quantities of soft ore to allow of a beneficial mixture.

LIMESTONE BELT.—Running parallel with these series of ore deposits, and directly west of the magnetic ore belt, is a narrow belt of dolomitic limestone which will serve as an excellent fluxing material. It has been opened at a number of points, among which may be mentioned the Shuford and Powell quarries in Catawba and the Keener quarry in Lincoln county.

The quality of this limestone is shown by the following analyses:

ANALYSES OF LIMESTONE FROM CATAWBA AND LINCOLN COUNTIES.

	(400)	(401)	(408)
Silica	1.28	2.60	0.45
Oxides of iron and aluminum.....	3.17	1.54	4.46
Lime	33.18	34.27	35.90
Magnesia	19.07	20.09	17.63

No. 400. From the Shuford quarry, Catawba county.

No. 401. From the Powell quarry, Catawba county.

No. 408. From the Keener quarry, Lincoln county.

This entire range of parallel ore deposits in Lincoln and Catawba counties may be made accessible by a railroad connection, some 24 miles in length, between the Western North Carolina and Carolina Central railroads, following almost the exact trend of the principal ore belt.

In Gaston county the ore-bearing formation consists of four parallel belts on the east side of the limestone: 1. That on which the Ormond mine is situated. 2. Little mountain. 3. Yellow Ridge. 4. Crowder's and King's mountains.

THE ORMOND MINE is situated 1 mile due west from Bessemer City, with which it is connected by a short branch railroad. This is probably the most interesting mine in Gaston county, because it has been most extensively worked, and is in fact the only iron ore mine, besides that at Cranberry in Mitchell county, that has been in operation during the past years. The country rock is silicified, talcose schist, decomposed to considerable depths. The strike is N. 25° to 30° E.; the dip is to the north-west from 75 degrees to the vertical.

The character of the ore is varied; practically speaking there are four classes: 1. A hard, block ore, solid and jointed in structure, containing generally less than 5 per cent. of combined water,

and hence classified as *turgite*. 2. A loose, pulverulent, bluish-black ore, locally called *powder ore*, from its fineness and color. 3. A porous, brown hematite or *limonite*. 4. A very hard, homogeneous ore, almost black in color and slightly *magnetic*. These exist in various proportions, though the first variety may be said to predominate. Nearly all of it is slightly manganiferous, and in fact the powder ore may be considered a decomposed variety of manganiferous block ore, and is often found filling up the interstices formed by the joints and cracks in the same.

As a rule the ore bodies are remarkably free from mechanical admixture or gangue, and the ore is very pure. The structure of the beds is eminently lenticular, the lenses lapping over each other longitudinally and vertically, with a general north-westerly dip varying from 70° to nearly vertical. In mining their position is traced by small stringers or leaders of ore, and by the flow of water which follows them. The hanging wall is usually a decomposed gneiss or slate, and the foot-wall a soft, black muck, which has been found to contain a considerable amount of fine black ore. The ore formation is continuous in length over the 2,400 feet, and indeed there is no proof that it does not continue still farther in either direction.

Transversely to the strike the ore bodies occupy a width varying probably from 50 to 100 feet. In the western drifts on the lower level (depth 173 feet) of shaft No. 4 a solid limestone ledge has been encountered, and this is probably the western boundary of the ore formation. As to the size of the separate lenses, they vary in thickness from less than 3 to more than 28 feet, holding out well in length and depth, though no definite figures can now be given of the latter, owing to insufficient development.

ANALYSES OF ORE FROM THE ORMOND MINE, GASTON COUNTY.

	(204a)	(204b)	(196)	(204d)	(204e)	(197)	(199)
Silica.....	.....	.....	9.72	.....	.....	1.55	1.51
Metallic iron.....	64.40	63.52	52.39	47.10	66.60	65.35	65.79
Sulphur.....	.....	.....	0.048	.....	.....	.....	.....
Phosphorus.....	0.036	0.033	0.079	0.057	0.019	0.007	0.028
Phosphorus ratio..	0.055	0.051	0.150	0.121	0.028	0.010	0.042

THE LITTLE MOUNTAIN MINE is situated $\frac{1}{2}$ mile east of the Ormond mine. The country rock is a silicified slate; its strike is N. 37° E., and dip from 70° N. W. to the vertical. The character of the ore is brown hematite containing from 4 to 13 per cent. of combined water, and accordingly classified variously as turgite, goethite and limonite. The ore is probably pseudomorphous after siderite. It occurs in a bedded quartz vein, conformable to the schistosity. The vein matter consists of an admixture of crystalline quartz and pure ore in varying proportions. On the outcrop it is very lean, the quartz predominating; in depth the quartz gradually diminishes until at the bottom of the 60-foot shaft the material is nearly pure ore. The vein matter for the first 30 feet in depth is profusely mixed with quartz, and ore clean enough for shipping purposes can hardly be mined until that depth is passed; at this point the vein is 10 feet thick; at the bottom of the shaft it is also 10 feet thick of practically clean ore. In the drifts both north and south, on the 60-foot level, the thickness varies from 17 to 27 feet (so reported by the general manager).

ANALYSES OF ORE FROM THE LITTLE MOUNTAIN MINE, GASTON COUNTY.

	(207a)	(207b)	(208)	(209)
Silica.....	7.90	11.96	1.64	5.31
Metallic iron.....	53.75	52.70	61.20	58.37
Metallic manganese.....	.....	.....	0.77	3.20
Sulphur.....	0.011	.....	0.090	0.113
Phosphorus.....	0.045	0.022	0.009	0.005
Phosphorus ratio.....	0.088	0.041	0.015	0.009

All of the analyses given show it to be a Bessemer ore, ranging from 1.42 to 11.96 per cent. silica, and from 52.70 to 61.20 per cent. metallic iron. There is a loose, pulverulent variety which is high in manganese, averaging over 3 per cent.; but by far the greater proportion will not average above 0.50 per cent. of metallic manganese.

The average grade of ore that can be mined and shipped directly, without further treatment, is probably best represented by analyses Nos. 207a and 207b. The ore will not require washing; but much of the leaner material, heavy in quartz admixture, can undoubtedly be successfully improved, by crushing and jigging, to produce a high-grade product.

THE YELLOW RIDGE BELT has been worked in former years at the Costner, Ellison, Ferguson, Fulenwider, and Yellow Ridge mines. The country rock is a hornblende schist. Its strike is N. 20° E.; the dip being steep to the north-west. The ore is magnetite. The thickness of the ore bodies varies from less than 1 to 20 feet, averaging about 7 feet. At many points pyrites appears in depth. Some analyses show :

ANALYSES OF MAGNETITE ORE FROM THE YELLOW RIDGE BELT, GASTON COUNTY.

	(211)	(217)	(218)	(218a)	(221)	(223)
Silica.....			4.67	12.82	.....	.....
Metallic iron.....	52.00	54.71	67.18	57.60	37.40	57.49
Sulphur			0.11	0 016	1.50	0.100
Phosphorus.....	0.002	0.016	0.050	0.082	0.020	0.010
Phosphorus ratio.....	0.004	0.029	0.07	0.142	0.053	0.017

The ores of Crowder's and King's mountains are unimportant, as far as present explorations have shown.

IRON ORES IN THE MOUNTAIN COUNTIES.

An important series of magnetite ore deposits occur in Ashe, Mitchell and Madison counties. These lie entirely within the zone of the crystalline schists, consisting chiefly of hornblende and mica gneisses and schists. The structure of the ore beds is lenticular, and as such they occur distributed over a rather undefinable area, though there is some regularity in the direction of their outcrops, which have a general trend north-east and south-west.

MAGNETITE ORE BELTS IN ASHE COUNTY.

In Ashe county there are three main belts, attaining their greatest development in the north-eastern portion of the county. Their location is indicated on the accompanying topographic map (Plate V). They are: 1. The Ballou or River belt. 2. The Red-hill belt. 3. The Titaniferous belt.

THE BALLOU OR RIVER BELT is the most easterly of the three principal ore belts, and crops out along the course of North fork of New river. There are practically two divisions of this belt, in distinct and parallel outcrops, lying about $\frac{1}{2}$ mile apart, and



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characterized mainly by difference in gangue, the most north-westerly being massive hornblende-epidote, and the other micaceous and hornblende schists.

One of the most important deposits in this belt is the Ballou ore bed, where present explorations show a thickness of 12 feet. The strike is N. 45° E., and the dip is 37° S. E.. The ore is a hard, compact magnetite in a gangue of hornblende, epidote and quartz. The highest point of the outcrop is probably 260 feet above the level of the North Fork of New river.

ANALYSES OF MAGNETITE ORE, N. B. BALLOU'S HOME PLACE, ASHE COUNTY.

	(19)	(20)	(21)	(22)
Silica.....	17.88	20.79	.....	.....
Metallic iron.....	50.68	45.50	60.81	49.06
Sulphur.....	0.02	0.002	.....	.....
Phosphorus.....	0.009	0.024	0.023	0.018
Phosphorus ratio.....	0.017	0.052	0.037	0.037

No 21 is an analysis of better selected sample of ore.

THE RED-HILL OR POISON-BRANCH BELT crosses from the north-western corner of Alleghany into the north-eastern corner of Ashe county, and extends thence in a general south-westerly direction, its several lines of outcrop crossing over Grassy creek, Helton knob, Red-hill, Helton creek, McClure's knob, Old Field, Silas, Piney and Horse creeks, a distance of some 10 miles as far as traced.

Some of the principal deposits are the Pugh, Black, Blevins, Red-hill, McClure's knob, Poison-branch, Piney creek, Francis, Graybeal and Horse creek. In the northern portion of the belt the ores are granular magnetites disseminated in mica and hornblende schists. The strike of the schists is N. 40° to 50° E., and the dip is 40° to 50° S. E. The ore beds are as high as 200 feet in width; and the ores are, as a rule, of Bessemer quality, though in two instances they are exceptionally high in phosphorus.

ANALYSES OF MAGNETITE ORES, ASHE COUNTY.

	(3)	(93)	(54)	(55)	(59)	(57)	(66)
Silica.....	22.74	21.62	19.83	32.06	21.58	11.46	12.31
Metallic iron.....	45.44	48.10	51.55	37.14	47.07	51.30	56.05
Sulphur.....	0.049	0.06	0.137	0.071	0.05	0.06	.....
Phosphorus.....	0.022	0.036	0.042	0.004	0.07	1.12	0.071
Phosphorus ratio.....	0.048	0.074	0.081	0.010	0.148	2.138	0.127

Towards the south-western part of the belt the ores become manganese—and in places very highly so—as shown in the following analyses:

ANALYSES OF MANGANIFEROUS MAGNETITE ORES, ASHE COUNTY.

	(28)	(29)	(33)	(35)	(32)	(43)
Silica.....	3.12	10.64	10.82	6.09	1.73	4.58
Metallic iron.....	62.10	39.35	47.43	47.45	64.51	54.02
Metallic manganese.....	3.66	9.63	8.96	9.10	3.19	6.85
Sulphur.....	0.085	.....	.....	.....	0.040	0.007
Phosphorus.....	0.017	0.022	0.085	0.102	0.120	0.006
Phosphorus ratio.....	0.027	0.056	0.180	0.215	0.186	0.011

THE TITANIFEROUS ORE BELT.—Starting at the northern edge of the county, near the Virginia State line, on the waters of Little Helton creek, this, the most south-westerly ore belt of importance in Ashe county, has been traced in a north-westerly direction to Helton creek, near Sturgill P. O., a distance of some $2\frac{1}{2}$ miles. It is approximately 3 miles north-west of the Red-hill belt and parallel to it. The ore bodies vary from 3 to 25 feet in thickness.

ANALYSES OF TITANIFEROUS MAGNETITE ORES, ASHE COUNTY.

	(80)	(79)	(77)	(75)	(72)	(71)
Silica.....	5.12	5.37	9.90	6.35	4.75	17.25
Metallic iron.....	50.77	51.75	46.81	57.66	52.23	48.87
Sulphur.....	0.04	.....	0.137	0.061	0.112	0.057
Phosphorus.....	0.005	0.018	0.025	0.008	0.021	0.066
Titanic acid.....	4.950	9.170	6.030	4.690	8.910	0.210
Phosphorus ratio.....	0.009	0.034	0.053	0.013	0.040	0.135

In general the quality of the Ashe county ores is good; low in sulphur and below the Bessemer limit in phosphorus.

The mined material will, in many cases, be high in silica, but there is no reason why in such cases, by means of magnetic concentration, a high-grade product should not be obtained.

The titaniferous belt is by far the most persistent, and shows a larger quantity of ore, but the percentage of titanic acid condemns it for blast-furnace use, in competition with iron ores less difficult to smelt in the furnace.

There is little doubt that there are valuable workable beds of ore throughout the other two belts, such as Ballou's, Piney-creek, Gray-

beal's, Horse-creek, etc., but it will require much more extensive exploitation to define their true extent.

Nearly all of these ore deposits, being situated on the tributaries of North fork of New river, would be accessible to a railroad built up that stream, which is a feasible project.

IRON ORES IN MITCHELL COUNTY.

The principal ore deposits of Mitchell county are situated in the northern and north-western parts of the county, on the slopes of the Roan, Iron, Unaka and Pumpkin Patch mountains.

In the upheaval of the Roan and contiguous mountain ranges in Mitchell county, N. C., and Carter county, Tenn., and of the Beech mountains in Watauga county, N. C., certain dynamic causes have operated to radically deflect the position of their axes from the normal trend, and consequently the course of the ore-bearing formations over this territory has suffered similar deflections, bending in a long bow or arc from the northern part of Mitchell county at Cranberry, where the strike of the country rocks is north of west, through the southern portion of Carter county, Tenn., re-crossing the State line into North Carolina, and gradually assuming its normal trend, south of west, in the western part of Mitchell county.

The principal ore deposits of Mitchell county may be divided into four belts:

- (1). The Bald mountain specular belt.
- (2). The Cranberry magnetite belt.
- (3). The Roan mountain titaniferous magnetite belt.
- (4). The Pumpkin Patch titaniferous magnetite belt.

The red hematite deposit of Bald mountain is reported to be 10 feet in thickness. The ore is fine-grained and compact; it is siliceous near the outcrop. The country rock is silicified slate, striking N. 25° E. This general belt has been traced in a south-westerly direction for 7 miles to the Toe river.

ANALYSIS OF SPECULAR HEMATITE, BALD MOUNTAIN, MITCHELL COUNTY.

	(325)
Silica.....	13.73
Metallic iron.....	52.80
Sulphur.....	0.06
Phosphorus.....	0.097
Phosphorus ratio.....	0.183

THE CRANBERRY MAGNETITE BELT contains by far the most important deposits of ore in this region, and has been the most extensively developed. (See Plate I, frontispiece, and Plate VI, accompanying this description).

Its eastern extremity is found at Cranberry in the northern part of Mitchell county; thence it is traced without difficulty in a direction approximately N. 34° W. for 2½ miles to the Tennessee line, which it crosses near the line of the W. N. C. and E. T. railroads; it passes through the southern portion of Carter county, Tenn., deflecting gradually westward, and thence south-westward to the headwaters of Tiger creek, recrossing into North Carolina over Iron mountain, at an elevation of nearly 4,000 feet (above sea-level), to the headwaters of Greasy creek, and continuing in a normal south-westerly direction to the Toe river, near the mouth of Pigeon Roost creek, a total distance of some 22 miles.

The most important deposit in this belt, indeed the most important in the State, is that at the Cranberry mine. It occupies the eastern slope of Cranberry ridge, the highest outcrop being 380 feet above the level of Cranberry creek. The present workings cover an area of nearly 8 acres, and consist of two tunnel openings and four main open cuts in successive levels or benches. The ore body has been explored and opened up for 875 feet in length by 300 feet in width by 275 feet maximum depth (about 165 feet average depth), representing approximately 1,600,000 cubic yards. Assuming that the gangue and ore are equally divided, half and half, and taking the specific gravity of magnetite at 5.1 and of the gangue at 3.0, this volume would contain 4,800,000 tons (gross) of ore material, of which over 3,000,000 tons are pure ore. The ore is magnetite, varying from fine to coarse granular. The gangue rock consists of hornblende, pyroxene, quartz, feldspar, epidote, calcite, garnet, allanite, zircon and serpentine. The de-

posit may be considered as one vast body of ore and rock, the ore being promiscuously distributed through the rock, but usually partaking of the form of lenses and bands. The strike is N. 34° W., and the dip 45° S. W. The country rock is gneiss.

ANALYSES OF RUN OF MINE ORE, CRANBERRY MINE, MITCHELL COUNTY.

	(292)	(293)	(294)	(295)	(298)	(311)	(312)
Silica	26.64	23.73	25.96	35.48	20.97	.....	30.10
Metallic iron.....	42.78	45.90	44.19	34.02	45.93	44.29	32.49
Metallic manganese..	0.51	0.44	0.40	.....	0.31	.....	.....
Lime	10.80	9.69	10.62	.....	10.10	.....	11.37
Magnesia	1.85	1.51	1.67	.....	1.43	.....	1.78
Sulphur.....	0.023	0.012	0.041	0.047	0.020	0.129	0.128
Phosphorus.....	0.0064	0.007	0.008	0.013	trace.	0.007	0.010
Phosphorus ratio....	.015	0.015	0.018	0.039	.....	0.016	0.031

ANALYSES OF SELECTED ORE, CRANBERRY MINE, MITCHELL COUNTY.

	(310)	(313)	(314)	(315)	(316)	(317)
Silica	5.29	4.16	5.74	11.48	9.08	4.02
Metallic iron.....	64.87	68.34	66.22	61.98	58.49	66.53
Lime.....	1.47	0.43	1.01	0.72	.....	1.06
Magnesia.....	.....	0.36	0.53	0.33	.....	0.23
Sulphur.....	0.115	.....	.....	.....	.....	0.25
Phosphorus	0.004	.....	.....	.....	.....	trace.
Titanic acid.....	0.950	.....	.....	.....	.....	.....
Phosphorus ratio.....	.006	.....	.....	.....	.....	trace.

The ore is concentrated on magnetic separators.

AVERAGE ANALYSIS OF FINE CONCENTRATES, CRANBERRY, MITCHELL COUNTY.

	(306)
Silica	8.33
Metallic iron.....	63.41
Metallic manganese	0.24
Alumina	0.41
Lime	3.12
Magnesia	0.49
Sulphur	0.045
Phosphorus	0.004
Phosphorus ratio.....	0.006

A portion of the ore is shipped to outside furnaces, while a portion is smelted in the small 15-ton furnace at the mine. The limestone for this purpose is obtained from Carter county, Tenn., and

the coke from Pocahontas, Va. The average value of the shipping ore at the mine is \$1.40 per ton.

ANNUAL PRODUCTION OF IRON ORE AT THE CRANBERRY MINE, MITCHELL COUNTY,
IN GROSS TONS (2240 LBS.).

1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
3,998	17,839	24,106	45,032	15,705	19,819	30,290	27,628	18,433

SHIPMENTS OF IRON ORE FROM THE CRANBERRY MINE, MITCHELL COUNTY,
IN GROSS TONS (2240 LBS.).

1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
not known.				10,129	12,974	22,873	20,284	12,088

TOTAL PRODUCTION OF PIG-IRON AT THE CRANBERRY FURNACE, IN GROSS TONS.

1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
388	1,598	1,964	3,250	2,143	2,587	2,840	3,217	2,902

This iron is valued at \$16 per ton at the furnace, and is shipped to furnaces and steel works in Ohio, Pittsburgh, Pa., Bethlehem, Pa., etc. Much of it is used in the manufacture of crucible tool steel. It is of a special Bessemer grade, averaging less than 1.00 per cent. silicon and less than 0.025 per cent. phosphorus.

The possibilities of the Cranberry mine as an iron ore producer have never been fairly demonstrated. The policy of the company has been rather to develop the magnitude of the deposit by slow exploratory work than to combine that very important feature with a larger output. There is no reason why this should not be made a large and steady producing iron ore mine. Operations on a large scale will also tend to reduce the cost of mining materially.

The Roan mountain and the Pumpkin Patch titaniferous belts are too insufficiently developed to warrant any special description here. The titanic acid in the ores reaches as high as 6.00 per cent.

IRON ORES IN MADISON COUNTY.

In Madison county a body of magnetite ore, resembling very much that at Cranberry, is exposed at the Big Ivy or Heck mine. This mine is situated 6 miles due north from Alexander's Station on the Western North Carolina railroad. It is on the northern

slope of a hill some 285 feet above the level of Big Ivy creek. The country rock is hornblende schist, striking N. 50° E. The total thickness of the ore exposed is 52 feet.

ANALYSES OF MAGNETITE ORE, BIG IVY MINE, MADISON COUNTY.

	(286)	(287)
Silica.....	15.54	.....
Metallic iron.....	48.54	42.97
Sulphur	0.012	.....
Phosphorus.....	0.019	0.005
Phosphorus ratio.....	0.039	0.012

BROWN HEMATITE DEPOSITS, CHEROKEE COUNTY.

The brown hematite ore deposits of Cherokee county are among the most important in the State. The ore beds of value occur in the calc schists immediately below the quartzites and above the marble.

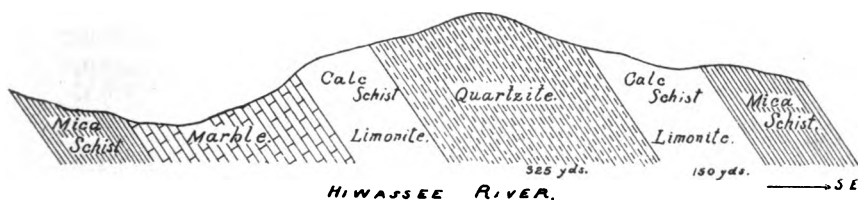


Fig. 2.—Section along Hiwassee river, showing position of iron ore.

The age of these rocks has been referred to the Lower Cambrian by Mr. Arthur Keith of the United States Geological Survey.

These ore beds are persistent and of good body and quality, though high in phosphorus. The principal deposits extend in a north-easterly direction from Murphy, the county-seat, up the valley of Valley river for a distance of some 16 miles, which may be called the *Valley River Belt*.

The ore-bearing schists continue also in a south-westerly direction from Murphy, up the valley of the Nottely river, but have not been carefully explored, and, excepting at one point, no notable deposits have yet been discovered.

South of Murphy, on the waters of Martin's creek, ore-bearing formations have been found, but only slightly explored; these are parallel ranges to the above main belt.

In the valleys of Peachtree and Low creeks, some 6 miles east of Murphy, local deposits of ore have been found, but not developed.

Beds of marble everywhere accompanying this ore, lying geologically beneath it, will furnish a convenient fluxing material.

Beds of talc, often of great purity, occur locally as lenses in the upper portions of the marble.

The Valley river belt is a double outcrop along the parallel edges of a sharp synclinal fold. These outcrops appear on both sides of a quartzite ridge, striking N. 40° E. They extend to a point near Valletown, and have been opened at intervals all along this distance. They are everywhere accessible to the Murphy Branch of the Western North Carolina railroad. The thickness of the ore beds varies from less than 3 to more than 40 feet.

AVERAGE OF 8 ANALYSES OF SAMPLES OF VALLEY RIVER BROWN HEMATITE ORES
COLLECTED BY THE N. C. G. S.

Silica	8.312
Metallic iron.....	54.937
Sulphur	0.055
Phosphorus	0.476
Phosphorus ratio.....	0.866

ANALYSES OF MARBLES, CHEROKEE COUNTY.

	(402)	(403)	(404)	(405)
Silica	2.93	0.92	1.58	1.20
Oxides of iron and aluminum.....	1.17	1.20	1.90	0.82
Lime	49.83	32.80	32.42	52.90
Magnesia	3.61	15.43	19.58	1.91

In the extreme western part of Madison county, south of the French Broad river, near the Tennessee State line, deposits of brown hematite and manganese ore occur, in all probability bearing geological relations to the inclosing rocks similar to the Cherokee deposits. The prospects for finding good deposits of brown hematite and manganese ore in this locality are encouraging, and the section will warrant a closer and more detailed investigation.

Similar deposits of brown hematite are reported to exist along the south-eastern slopes of the Unaka mountains, the north-western boundary of Mitchell county, and are probably an extension of this same general ore horizon.

NORTH CAROLINA GEOLOGICAL SURVEY.

NOTES ON BUILDING AND ORNAMENTAL STONE,

BY

J. V. LEWIS.

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NOTES ON BUILDING AND ORNAMENTAL STONE.

BY J. V. LEWIS.

INTRODUCTION.

Stone-cutting and quarrying is one of the most recently developed industries in North Carolina, and hence its history is a short one. Except for local and special demands, no quarries were operated in the State until within the last five or six years. However, considerable quantities of stone have been obtained in a few places and small amounts quarried in many localities for such work as railroad culverts, bridge piers, street-paving and macadamizing. But, until recently, the systematic quarrying of building stone had not been undertaken.

The absence of any adequate publication or exhibit on this subject and the small demand in the Southern States for the more expensive building materials are prominent among the causes which have heretofore prevented a more thorough appreciation and development of these resources. During the past few years, however, along with advancement in other lines there has been developed in this region a small but growing demand for more permanent buildings; a lively interest has been aroused in the utilization of Southern resources; and, in North Carolina, the building stones are beginning to receive their proportionate share of attention.

The results are seen in the nine quarries now in operation in the State, employing an aggregate of nearly five hundred men and turning out over a hundred car loads of stone a week. While some of these are operated on a small scale and are still in the experimental stage, others, finding a steady demand for their products, have developed beyond that point and are enlarging their equipment and increasing their working force. A few already appear to be flourishing industries, employing from fifty to two hundred men, and are equipped with modern appliances and skilled labor.

No extensive tests have been made for hardness, specific gravity, crushing strength, or absorption, and such general information as is contained in the following notes has been obtained by brief visits to the quarries and examinations of the stone both in place and, where possible, in buildings in which it has been used.

In regard to the working qualities of the various stones, their uses and markets, and the dates of opening and closing quarries, it will be understood that the owners and quarrymen were the principal sources of information. In the main the statements are believed to be correct.

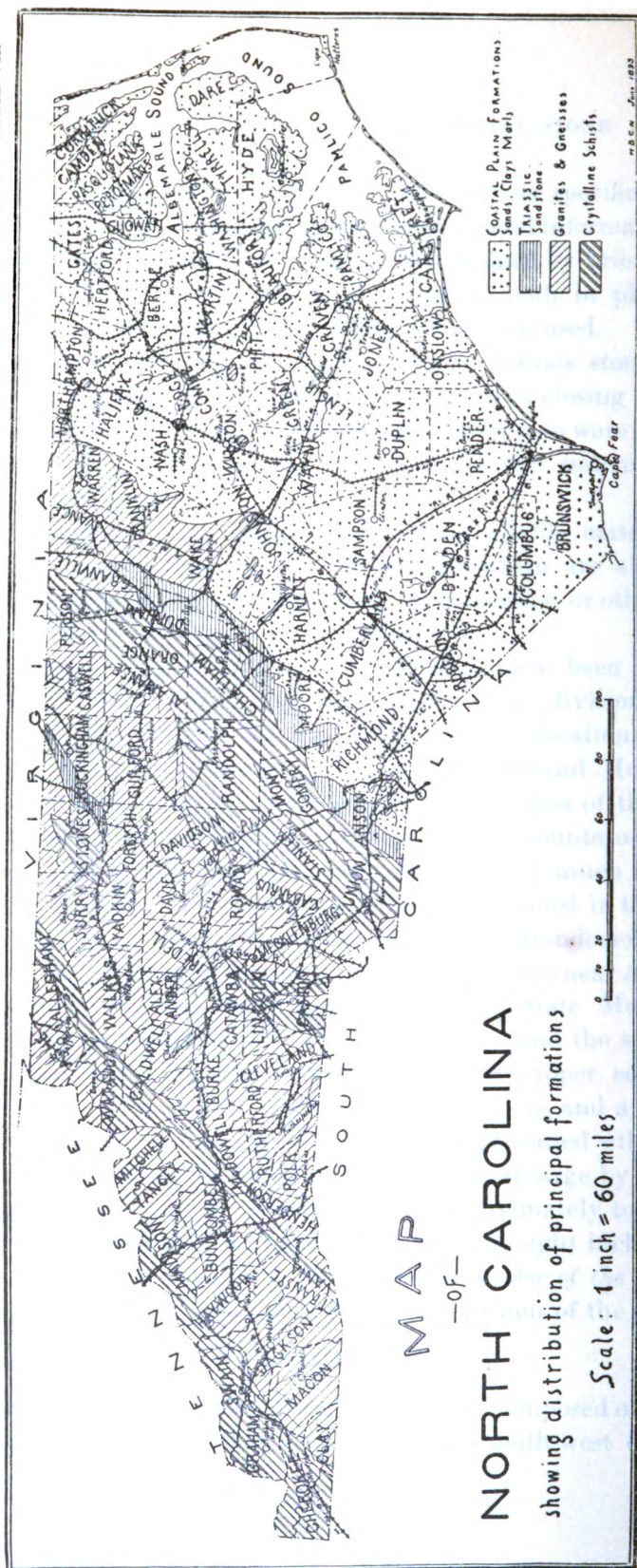
No attempt is here made to cover all available material, but simply to give a brief account of deposits which are already of economic importance, or which, from their location or other favorable conditions, are likely soon to become so.

No granites or gneisses of any importance have been quarried west of the Blue Ridge, and hence there is no division for this section of the country in the following classification. Small amounts of gneisses have been used in Asheville and Hendersonville from local quarries, but in general the gneisses of this whole region have been rendered too schistose by the mountain-building forces to which they have been subjected to be of much value for building purposes. An exception may be mentioned in the case of Mr. Troy's quarry (gray laminated gneiss) near Henderson, and in the case of Mr. Nichols' quarry (gray biotite granite) near Asheville.

A list of building stone specimens in the State Museum at Raleigh is appended at the end of this paper, and the specimens from each locality are also mentioned in their proper connection in the text. The exhibit is by no means complete, and any one in a position to furnish specimens of stone not represented will do good service to his own community and to the State at large by so doing. Blocks for this purpose should be cut approximately to ten-inch cubes (so that when dressed they will easily cut eight inches), carefully labeled and shipped by freight to the *Curator of the State Museum, Raleigh, N. C.*, accompanied by a description of the property.

CLASSIFICATION.

Approximately, the State may be said to be composed of parallel geologic belts crossing it in a north-east and south-west direction.



Three of these belts, in the middle and piedmont regions, carry most of the stone of present economic importance and constitute the first three divisions in the following classification (see map, Plate VII):

1. THE SANDSTONE BELT, which includes the brownstones of Anson, Moore, Chatham, Wake, Durham and Orange counties—all in the Triassic formation;

2. THE EASTERN GRANITES AND GNEISSES, including the gneisses of Vance and Wake counties, the granites of Franklin, Granville and Warren; and the small areas of granite exposed by removal of the coastal plain formations in Anson, Richmond, Wilson and Edgecombe counties;

3. THE PIEDMONT GRANITE BELT consists of the granitic and syenitic rocks of Gaston, Mecklenburg, Cabarrus, Iredell, Rowan, Davidson, Davie, Forsyth, Guilford and Alamance counties, constituting the "Lower Laurentian" belt on Kerr's map, and situated along the eastern border of the central "granites and gneisses" of Plate VII. Although not closely connected with this granite belt, the Mt. Airy quarry in Surry county, and the peculiar gneiss of Taylorsville, Alexander county, forming a part of the same great central body of granites and gneisses, are considered under this head.

4. OTHER ECONOMIC STONES: slate, serpentine, quartz-porphry, quartzite, soapstone, limestone in the eastern counties and marbles in the western counties.

THE SANDSTONE BELT.*

A line drawn on the map from Wadesboro to Henderson would be almost exactly N. 45° E. Along this line, from the southern border of Anson county and extending nearly to Oxford in Granville county, lies a belt of slates and sandstones of Triassic age which carry the coal beds of Egypt and vicinity. This belt has a maximum width of about 15 miles and extends nearly across the State. It is the same geological formation which, in Connecticut, Pennsylvania and New Jersey, furnishes the famous brownstone of our Northern and Eastern cities. In referring to this North

*Some of the data contained in these notes have already been published in the *Hand-book of North Carolina*, 1893, pp. 294 and 295, where, by mistake, they were credited to Mr. Geo. B. Hanna.

Carolina belt, Mr. Geo. P. Merrill, Curator of Geology in the United States National Museum, says: "The narrow belt of Triassic sandstone already mentioned as passing through this State furnishes fine, compact, light and dark reddish brownstone of a quality not at all inferior to any of that in the more northern and eastern States."*

QUARRYING.—The jointage of the Triassic formation assists very materially in quarrying, and prevents the necessity for heavy blasting, frequently dispensing to a considerable extent with blasting of any kind. Those who realize the injurious effects of blasting in sandstone will readily understand the great advantage of this.

Where the joints are not sufficiently near together the usual method is to put in light blasts and loosen large blocks, which are afterward split into dimension stone with *plugs* and *feathers* in holes along the line of the desired break. Nearly all of our sandstone has a distinct rift parallel to the bedding planes, but most of it splits equally well in either of the other two directions; in other words, it seldom shows a distinct grain. Other points in quarry practice will be mentioned as the various quarries come under consideration.

THE SANDSTONE OF ANSON COUNTY.

Within four or five years three quarries have been opened in the brownstone of this region, but none of them were in operation at the time my examination was made. The stone from all these is homogeneous, fine-grained, and quite compact. The color is reddish-brown, varying in places to grayish-brown and gray. A fine-grained specimen of light brown color from this locality may be seen in the State Museum. The average dip is about 20° south 25° east. In the compression tests given by Mr. Merrill the block from Wadesboro cracked at 8,000 pounds per square inch, and was crushed at 11,168 pounds.†

*Stones for Building and Decoration, page 274.

†*Ibid.*, page 412.

The chemical composition is given in the same place as follows:

Silica.....	69.28	per cent.
Alumina and iron oxides.....	13.84	" "
Magnesia.....	.02	" "
Potash and soda	6.43	" "

The stone here, as well as throughout the sandstone belt, hardens considerably on exposure. It works quite easily when freshly quarried, being split, dressed or carved with great facility; but blocks that have been exposed for some time to the air and sun become so refractory as to render their being worked quite impracticable. This property, which is found in many stones, is thought to be due to the evaporation of the *quarry water*, which, while remaining in the stone, holds small quantities of lime or other cementing materials in solution.

THE FRANK HAMMOND QUARRY is two miles south of Wadesboro and the work done has been somewhat in the nature of prospecting, but little stone having been shipped. Except for the two miles of rather hilly road over which the stone must be hauled to the nearest shipping point, the location is quite favorable. It is in a hill-side which rises abruptly to a height of about fifty feet above a small branch. But little stripping would be necessary, and natural joints and bedding planes break the stone into small and medium-sized blocks, some of which contain as much as 75 cubic feet of workable stone.

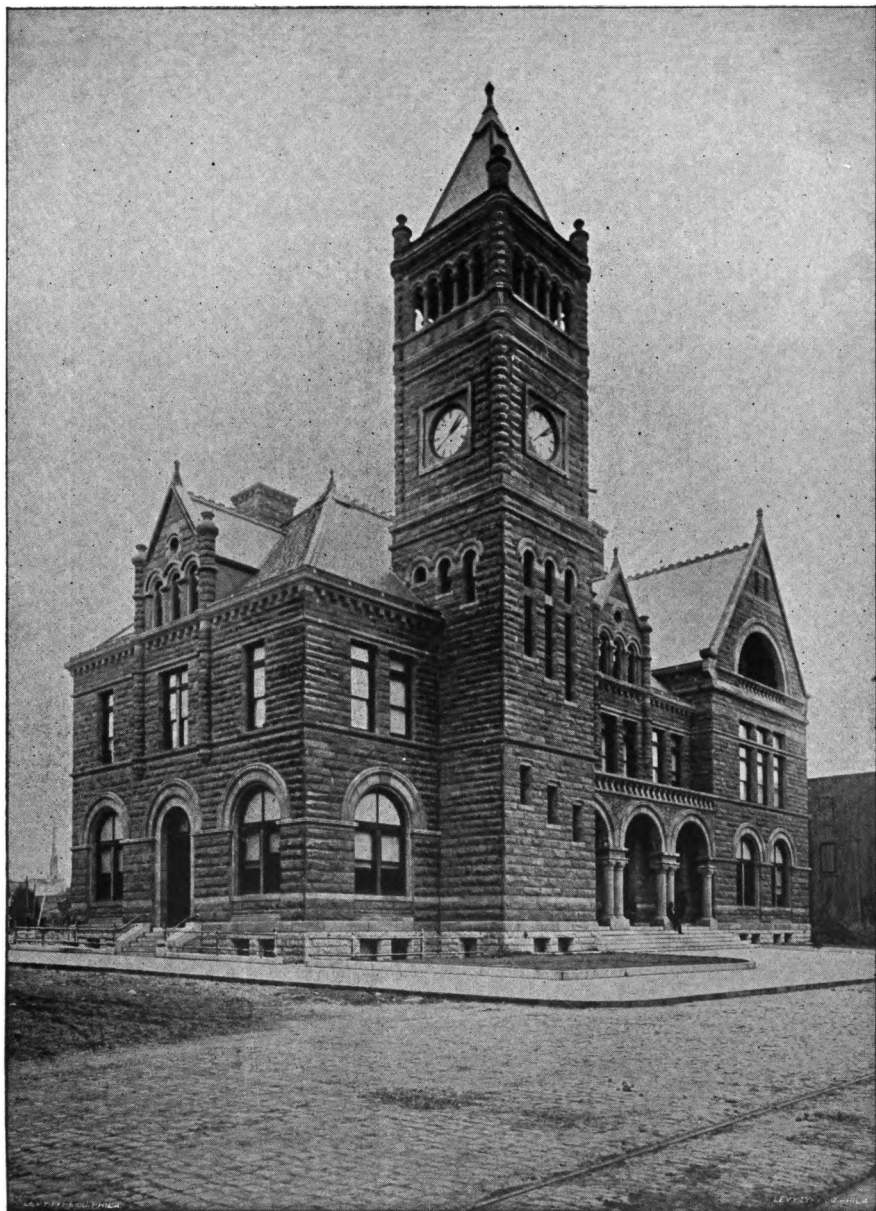
THE LINEHAN QUARRY, the property of P. Linehan, Raleigh, is one mile north of Wadesboro, near the Carolina Central railroad and connected with it by a switch. The quarry, which has been worked on a small scale, is almost entirely above water in a low hill. The present heading is about twenty feet high and two hundred feet long. The stripping is ten to twelve feet, consisting of soil and shaly, weathered sandstone. This includes several thin beds, however, which furnish some good stone. The main bed worked is about eight feet thick and is broken by rather irregular joints two to ten feet apart and following very nearly the dip and strike. The beds dip south-east about 20°, and, the quarry facing north-west, the work advances in the direction of the dip.

Blocks of five hundred cubic feet are obtainable. The stone is of fine, even grain, and fairly uniform reddish-brown color, a little brownish-gray stone appearing at one end of the quarry. Both rough and dressed stone was shipped; and two hand-power derricks were used for hoisting and loading it on the cars.

THE WADESBORO BROWNSTONE COMPANY'S QUARRY is about one-fourth of a mile west of Linehan's, and one mile from Wadesboro. It, too, is connected by a switch with the Carolina Central railroad. The quarry was opened in 1887 and worked till June, 1891, a space of about one hundred by one hundred and fifty feet being excavated in a bluff about thirty feet high. It is estimated that 100,000 feet of stone was shipped. The quarry face or heading at present is about one hundred and fifty feet long and thirty feet high, most of it above water, though a good deal of work has been done below the level of the branch on account of the large amount of stripping necessary to advance into the hill. In this work a small steam pump was used to drain the quarry, and in wet weather work was frequently suspended. As much as fifteen feet stripping, consisting of soil and beds of more or less decayed stone, had to be removed in some places. Some of these beds, however, occasionally furnished workable stone. The principal work was done in beds three to eight feet thick and dipping 20° south 25° east—the direction of advance in quarrying. These beds are broken into convenient sizes for working, and blocks containing four or five hundred cubic feet are easily obtained. The prevailing color is a reddish or chocolate-brown with some stone of gray and intermediate shades. The texture is quite uniformly fine-grained, but usually somewhat coarser in the lighter colors.

A sawing plant was run in connection with the quarry, and all stone was shipped sawn or rough. Rough dimension stone was sold at seventy-five cents per cubic foot; sawn on two sides at one dollar; sawn on four sides at one dollar and twenty-five cents per foot.

Specimens of this stone may be seen in the post-office and Federal court buildings of Wilmington (Plate VIII), Asheville and Statesville; the Young Men's Christian Association buildings at Charlotte and Atlanta, and in the Garrett school building in Baltimore.



POST-OFFICE BUILDING, WILMINGTON. BROWNSTONE.

Fifty to seventy-five men were employed, and the quarry equipment consisted of two boilers and engines of about fifty-horse power each ; five gangs of saws, one steam drill, one steam-power derrick of fourteen tons capacity, and two horse-power derricks.

SANDSTONE QUARRIES IN MOORE COUNTY.

QUARRIES NEAR SANFORD.—With one exception the brownstone of the Sanford quarries is similar to that of Wadesboro. It is not quite so hard, but the reddish-brown color and fine, even grain are much the same ; perhaps the Sanford stone is a little more uniform in both. Several specimens of brown and gray and intermediate shades from this locality are on exhibit in the State Museum.

The exception above referred to is the Rackle and Lawrence quarry, which is in beds that seem to lie above those of the other quarries in the vicinity. The *data* at hand seem to show the existence of a small syncline to the south-west of Sanford and running out near the village, its axis lying north-east and south-west. If this surmise be correct, the Rackle and Lawrence quarry is very near the axis of this syncline, and therefore geologically above those at its borders. The characteristic distinction of this stone is noted in the description below.

CAROLINA BROWNSTONE COMPANY'S QUARRY is located about one mile north-west of Sanford, and within two hundred yards of the Cape Fear & Yadkin Valley railway, with which it is connected by a switch. This is the site of the old quarries from which stone was procured for the Confederate arsenal at Fayetteville. Blocks of the old workings are still to be seen with tool marks quite distinct and bearing no indications of decay.

This quarry was opened over a year ago and worked to a small extent. The main bed varies from seven to twelve feet in thickness, and dips 15° south 60° west. It is broken into large, irregular blocks by joints, usually perpendicular to the bedding. This greatly facilitates quarrying, and saves the stone from the shocks of heavy and frequent blasting. Two to six feet of soil over about four feet of cap-stone constitutes the stripping. A portion of the capping stone is utilized, though it is more clayey and of a deeper red color than the regular underlying bed. The main bed is of

fine texture and quite compact; the color is brown and slightly reddish; a fine-grained specimen of rich chocolate color may be seen in the State Museum.

Up to the time of the visit to this quarry all stone had been shipped rough, but the company intended to enlarge the quarrying facilities and add a force of expert stone-cutters. Prices are, for promiscuous blocks, fifty cents per cubic foot; for dimension stone, sixty to eighty cents, according to size. Although it has been opened but a short time, specimens from this quarry may be seen in St. Luke's Church in Norfolk and in the court-house in Bristol, Tennessee. A chemical analysis of an average sample of this sandstone gave the following result:

ANALYSIS OF SANDSTONE, CAROLINA BROWNSTONE CO.'S QUARRY, SANFORD.

SiO ₂	81.06
Al ₂ O ₃	4.26
Fe ₂ O ₃	8.91
MnO ₂	trace.
CaO	0.85
MgO	0.43
Na ₂ O	2.63
K ₂ O	0.97
Loss on ignition	0.70

The present force at the time of examination was twenty-five men. Two horse-power derricks, hand drills and quarrying implements constituted the equipment. The capacity of the plant was given at eight to ten car loads a week.

THE RACKLE AND LAWRENCE QUARRY is about a mile southwest of Sanford and about one-fourth of a mile west of the Seaboard Air Line railroad. It is the property of J. M. Wicker, of Sanford, and was operated for two years under a lease, beginning in 1890. The construction of a short switch from the railroad would obviate most of the disadvantages which compelled the suspension of operations; namely, the necessity of hauling the stone a mile over a rough road for shipment, that of rehandling the stone and the consequent loss from breakage of fine work, and the necessity of being limited to the shipment of stone of small dimensions. A fine-grained, light brown specimen from this quarry is

in the State Museum, also a specimen of medium brown color and texture presented by Mr. Wicker. The following is a chemical analysis of an average sample of the stone:

ANALYSIS OF SANDSTONE, RACKLE AND LAWRENCE QUARRY, SANFORD.

SiO ₂	76.94
Al ₂ O ₃	5.68
Fe ₂ O ₃	9.87
CaO.....	0.90
MgO.....	1.01
MnO ₂	trace.
Na ₂ O.....	3.59
K ₂ O.....	1.22
Loss on ignition.....	1.01

The quarry is situated in a depression near the head of a small branch which supplies water for the engine. The work that has been done is in the form of a pit, and pumps were necessary to drain the quarry; but by ditching a short distance down stream a depth of twenty or thirty feet could be worked with natural drainage. About 2,500 feet of stone were shipped while the quarry was in operation, nearly all of it being dressed at the quarry and cut by special contract. The beds vary from four to twelve feet in thickness and are somewhat irregularly broken by joints into blocks ten or twelve feet square, so that little blasting has been found necessary. The dip is about 15° south 70° west, and the stripping very thin, hardly exceeding three or four feet of loose soil. There is scarcely any sap rock or cap, but the top beds are found to be damaged sometimes by the penetration of roots, which, on decaying, bleach the rocks along their course.

As noted above, this quarry turns out a stone quite different from that of other quarries in the vicinity, and is doubtless working higher in the series. Stone of the ordinary brown color and medium fine texture is found here, but most of that worked is of a much finer texture and of a dark reddish-brown color. It is quite soft when quarried, and easily carved for trimmings and ornamental purposes, but it hardens considerably on exposure and is said to weather well, as far as tested. In some parts of the quarry considerable variation of texture is found, at times running into fine conglomerate; but the color is so uniform that these variations are scarcely noticeable except on close examination.

Examples of its use in building may be seen in the city hall of Charlotte and the post-office at Greenville, South Carolina. It has also been used to some extent in buildings of less prominence in Washington, Atlanta, Danville and Norfolk. This quarry will doubtless be extensively developed in the future.

The full force employed at the date of examination was about sixty men, including twenty skilled stone-cutters. The machinery consisted of a drill, derrick and pump—all operated by steam.

THE CO-OPERATIVE BROWNSTONE COMPANY'S QUARRY is about a mile south of Sanford, on the Raleigh and Augusta railroad and within three hundred yards of the track, with good grade for a switch. This company has not been long in existence and work has just been commenced on a small scale. The quarry is being opened in a north-west hill-side which slopes with the dip of the stone 15° north 80° west. A depth of twenty feet or more can be worked with natural drainage, and good dumping grounds are convenient. The stripping seems to be quite thin, and at present consists only of soil about three feet thick. The color, texture and other properties of this stone correspond very closely to that of the Carolina Brownstone Company, described above. A light brown, fine-grained specimen is in the State Museum.

Besides the places noted above there has been more or less prospecting done in several places in the county. The following are probably the most important of these:

The Stevens place, a half mile west of Sanford, has been prospected with a view to quarrying, in a hill-side sloping with the rock, which dips 10° north 30° east. Three core-drill borings to a depth of twenty-five to thirty feet show a good grade of light brownstone with but a thin soil covering and practically no cap.

IN THE VICINITY OF CARTHAGE several places were visited in the region west and north-west of the town, along the line of the proposed extension of the Carthage railroad. Many of these places show an excellent, fine-grained, compact red to brown sandstone, in natural outcrop, with every advantage for economic quarrying on a large scale, above water. On the property of Messrs. Grimm, McNeil and others, beginning within a half mile of the court-house, and continuing west and north-west for eight miles—entirely across the Triassic formation—are found numerous promising outcrops.

Many of them have not been prospected, but the stone may easily be examined in the natural ledges. Especially are the indications favorable for good quarry developments on the Grimm lands, in the bluffs along the south-west border of McLendon's creek. The Carthage railroad will doubtless be extended as soon as there is assurance of quarrying operations of sufficient importance. The stone in all this region is remarkably uniform in texture and color. Specimens of it may be seen in the court-house building at Carthage, where it has been subjected to severe tests. Two years after its erection in 1885 the building was burned down, and was afterwards rebuilt without replacing a single piece of the original stone, which was used for steps, window sills, column bases and porch-paving. None of these parts suffered serious injury except where masses of burning timber fell across steps or pavement, thus heating the blocks very irregularly. Some cracking and scaling resulted from this cause, but otherwise the stone all looks quite fresh and retains a good color.

In many places throughout this Triassic area stone of good brown and red colors and uniform texture may be seen in natural outcrop. Some of these have been worked a very little in almost every community for chimneys and tobacco barn flues, and many of them near the railroads will doubtless well repay further investigation.

SANDSTONE QUARRIES IN CHATHAM COUNTY.

Strictly speaking, at the time of my examination there were no quarries in Chatham county, but the developments on foot and the quality of the stone are deemed of sufficient importance to warrant their mention here.

EGYPT COAL COMPANY'S QUARRY, one-half a mile west of the village of Egypt, in a bluff about thirty feet high on the bank of Deep river, has been opened by a little work near the top of the bluff. This bluff extends at about the same height half a mile down the river. Between 3,000 and 4,000 feet of stone was quarried here in the fall of 1889 and still lies on the grounds, apparently unaffected by the weather. The tool marks are very distinct and the dressed surfaces are perfectly fresh. The beds dip about

12° south 55° east, and are broken by vertical joints running with the dip at distances of six to ten feet apart. The stripping consists of two to four feet of worthless cap rock or "sap" under about five feet of soil. Only small sizes were quarried, but blocks of five hundred cubic feet could easily be obtained. The color is a uniform brownish red, and the stone is fine-grained and quite compact. A slight lamination is observable in places, but most of the blocks quarried are entirely free from it. The following analysis is of an average sample of sandstone from this quarry:

ANALYSIS OF SANDSTONE, EGYPT COAL COMPANY'S QUARRY, EGYPT.

SiO ₂	75.50
Al ₂ O ₃	6.54
Fe ₂ O ₃	10.49
MnO ₂	trace.
CaO	1.17
MgO.....	0.81
Na ₂ O	3.76
K ₂ O	0.84
Loss on ignition	0.84

AT GULF, three miles above Egypt, on the Cape Fear & Yadkin Valley railway, on the left bank of Deep river, is a fine-grained red brown sandstone in a bluff about twenty-five feet high, the property of W. S. Russell, of Gulf. The beds are two to five feet thick, and dip away from the river 10° to 15° south, 25° east. The color varies to a lighter brown at the foot of the bluff, with some of the beds showing slight laminations. Blocks that were blasted out twenty-five years ago for local uses still present sharp edges, a good color, and show very little sign of disintegration. Just below this, on the same side of the river and constituting strata above the brownstone, is found a coarser-grained, hard, gray sandstone, used in the construction of the iron furnace at Gulf, which was built during the war, but the stone is still perfectly preserved, as far as concerns weathering.

Three specimens of gray and yellowish sandstone from near Gulf are to be seen in the State Museum, and represent deposits that will doubtless be opened up in the near future.

There are two good specimens of brownstone in the State Museum from "Taylor's quarry," Chatham county.

THE SANDSTONES OF WAKE COUNTY.

The eastern border of the Triassic belt passes through the entire length of the western side of the county, and, notwithstanding the gentle rolling nature of the topography of this region, the characteristic brownstone of the formation is found in natural outcrops in many places. Strictly speaking, it has not been quarried in the county, nor even prospected to any considerable extent, but there is probably good desirable stone to be found at various places accessible to the railroads.

SANDSTONE QUARRIES IN DURHAM COUNTY.

About Durham no quarries have been worked to any considerable extent, and places here mentioned have been opened principally to supply occasional local demands. No quarrying at all is done there now.

DUKE'S QUARRY, the property of B. L. Duke, is located at the junction of the Belt Line with the Lynchburg & Durham railroad, and is one mile from the depot. A little work was done here in the spring of 1891 for railroad purposes, and part of the sills and lintels of the new Trinity College buildings were quarried here at the same time. It is a medium to fine-grained, reddish-brown sandstone, and is quite compact, and much of it finely laminated; the striæ being so fine as not to be visible at a distance of a few feet.

No serious effect would result from this structure if the stone is only placed in the wall as it lies in the quarry—with the bedding planes horizontal. Otherwise weathering would induce exfoliation, or scaling, which so frequently disfigures the brownstone structures of our cities. In the quarry the stone is exposed in a bluff about fifteen feet high, with a stripping of about six feet overlying the principal beds. The outcrop is visible for several hundred yards along the bluff, and the solid stone is laid bare by shallow gullies in several places almost to the top of the ridge, which rises thirty-six feet above the railroad. Blocks of any desired size

may be obtained up to a thousand cubic feet. A specimen of this stone may be seen in the State Museum. The following analysis is of an average sample of stone from this quarry:

ANALYSIS OF SANDSTONE, DUKE'S QUARRY, DURHAM.

SiO ₂	59.60
Al ₂ O ₃	8.45
Fe ₂ O ₃	7.43
MnO ₂	trace.
CaO	7.25
MgO.....	1.14
Na ₂ O.....	6.53
K ₂ O	3.03
Loss on ignition.....	6.19

THE ROBERT I. ROGERS QUARRY, property of the Durham Land and Security Company, is situated about one mile east of Durham. It was opened about ten years ago to supply a local demand for door and window sills, fronts, and trimmings. Only two beds, in a low, gentle slope near the branch, were worked, and part of the old working is now under water. It has been worked occasionally, as the local market required, ever since the opening, but no systematic quarrying has ever been done. The beds dip 12° south 60° east. The largest blocks quarried contained about two hundred cubic feet, but much larger ones might easily be obtained. Some of the stripping, which is rather heavy, might be utilized, but it is quite different in color and texture from the main beds, being very fine-grained and of deep reddish-brown color, while the principal beds are grayish-brown and of medium texture.

Two miles south-east of Durham a coarse gray stone has been worked to a small extent for sills and foundations of factories and trimmings for other buildings in Durham.

NEAR BRASSFIELD, in the south-east corner of Durham county, near the North Carolina railroad, a light brown, fine-grained sandstone has been quarried to a small extent. Examples of its use in architecture may be seen in Raleigh in the building of the National Bank of Raleigh and in the steeple of Christ Church.

Two blocks of a very similar stone labeled "Brassfield?" are exhibited in the State Museum.

SANDSTONE DEPOSITS, ORANGE COUNTY.

THE "UNIVERSITY QUARRY" is located one and a half miles east of Chapel Hill, near the Raleigh road, and less than a mile from the western border of the Triassic formation. This furnished the coarse gray stone used for sills and steps in the University buildings, some of which were erected nearly a century ago. The stone is of a dark purplish-gray color and is quite hard. The quarry is in a steep bluff on the side of a trap ridge, and the color and hardness are doubtless due to some extent to the influence of the dike, which is scarcely more than twenty feet away. The beds are four to six feet thick and jointed into large blocks. The window sills in the oldest University building are almost intact. They were finished in *square drove* and the tool-marks are still distinct. Some of the old steps were removed in the summer of 1891, having worn down about half their thickness.

THE EASTERN GRANITES AND GNEISSES.

As stated in the classification, this division includes the gneisses of Vance and Wake counties; the granites of Franklin, Granville and Warren, and the small areas of granite exposed by the removal of the coastal plain formations in Anson, Richmond, Wilson and Edgecombe. With the exception of those at Greystone, Vance county, no quarries in this belt have been worked except for local purposes.

GRANITE QUARRIES IN VANCE COUNTY.

There are two quarries operated at Greystone, on the Raleigh & Gaston railroad, five miles north-east from Henderson. They are about half a mile apart and are working nearly the same grade of stone. Both are of uniform gray color, fine-grained, and good splitting quality. Both are operated principally on contract work, such as railroad bridges, street-paving, curbing, and rough foundation stones. Some dimension and dressed stone is quarried for general building purposes, but this constitutes only a small part of the business.

THE GREYSTONE GRANITE AND CONSTRUCTION COMPANY'S QUARRY is located about three-fourths of a mile north of Greystone station, with a switch running into the quarry. It was opened in 1889 and has been worked constantly to the present time (1892), most of the product being used in contract work in the Southern States. The opening at the time of the visit was about two hundred feet square and twenty-five feet deep, with natural drainage. The quarry is in the side of a hill which rises about twenty-five feet higher back of the present working, giving a vast amount of material available above water. The stripping varies from two to ten feet in thickness, about half of this usually consisting of loose soil. The beds* are almost horizontal and thin at the surface, while those of the bottom of the quarry attain a thickness of eight to ten feet. The joints are rather irregular and usually about ten degrees out of the vertical, but assist very materially in the quarrying. Blocks of any desirable size are obtainable. The color is uniform light gray with a pinkish cast. The texture is fine to medium, and also quite uniform; though quartz veins occur sometimes and, less frequently, segregations of black mica into irregular spots and streaks. By careful selection, however, these are usually avoided with little loss. A block of this stone is exhibited in the State Museum.

At the time that my examination was made (1892) there were about one hundred and fifteen men employed, including six skilled dressers and twenty-five paving-block men. The machinery consisted of two steam derricks and one hand-power derrick, three steam drills (one mounted on a quarry bar), and two hoisting engines of about twenty and fifty horse-power respectively.

P. LINEHAN & SONS' QUARRY is near the depot at Greystone and is also connected by a switch with the Raleigh & Gaston railroad. The old quarry, a few hundred yards away, was opened about twenty years ago and worked for several years, but operations at the present site began only eight years ago. The opening is about two hundred and fifty by six hundred feet, and twenty-five feet deep, with natural drainage. Here, too, the beds are quite thin at

*The term "beds" as used here, and in descriptions of gneisses in the following pages, is not given its strict geological significance, but should be understood in the sense of more or less uniform layers into which gneisses naturally break along the planes of schistosity.

the surface, but thicken to as much as fifteen feet in the bottom. The beds lie nearly horizontal and the joints have an average dip of 10° north 40° west; the latter are rather irregular, however, and are two to twelve feet apart. The stripping varies considerably, ranging from about two to fifteen feet, half soil and the rest thin beds of worthless stone. The color of the granite is gray and slightly darker than that of the Greystone Granite and Construction Company's quarry, owing to the greater abundance of black mica. The lamination is more distinct and the texture somewhat finer, but quartz veins are more frequent and sometimes six inches thick. It works well with the rift and grain, but is difficult to split across.

The usual force employed is thirty to fifty men and the machinery includes (1892) three steam derricks, one drill and two hoisting engines.

OTHER PLACES in Vance county which furnish promising outcrops of stone, similar to that at Greystone, are found in the vicinity of Middleburg and Williamsboro. No quarrying has been done at these places and hence nothing definite can be said of them.

GRANITE IN WAKE COUNTY.

The State quarries in Raleigh have been worked to supply stone for the Capitol and the Penitentiary respectively.

THE "CAPITOL QUARRY" is a mile and a half east of the State-house and near the Federal cemetery. The stone is a light gray quartzose gneiss and has been worked occasionally for local demand from very early times, but no quarrying of importance was done till the stone for the Capitol was obtained here about 1833 to 1836. Since then it has been frequently worked for other purposes, chiefly for paving-blocks and macadam for the streets of Raleigh. The principal opening is about five hundred by seventy-five feet and thirty feet deep, at least a half million cubic feet of stone having been removed. The planes of foliation are almost horizontal, and the beds vary from six inches to five feet in thickness. No jointing is distinctly visible, but quarrying is very much facilitated by the strong *rift* and *grain*. The quarry should have been stripped to a depth of eight or ten feet, but much of this cap-stone was used in the lower portions of the Capitol building and has stood

the weathering remarkably well although somewhat discolored. No serious disintegration is to be seen on the walls, but some scaling has been caused by frost at the foot of the columns of the east porch. Had only the perfectly sound, unweathered stone been used in the lower as in the upper part of the building, the absorption of moisture would hardly have been sufficient to cause scaling or serious weathering in our climate in an ordinary life-time. The frequent quartz "veins" in this stone constitute the principal objection to it. They are usually small, however, rarely exceeding two or three inches in thickness, and often curiously folded and crumpled, as may be seen in many parts of the Capitol walls. The texture is quite fine and uniform and the stone presents a good appearance in the sand-finish there used.

THE "PENITENTIARY QUARRY" is inside the enclosure and furnished stone for the foundations and walls of the prison. It was first opened in 1868 and has been worked for a variety of purposes—building, curbing, Neuse river improvements, etc. It is a hard gray gneiss of rather variable composition, being dark and micaceous in portions of the quarry, while in others it passes into a light feldspathic stone. The quarry is in the form of a pit about three hundred feet square at the surface and said to be over sixty feet deep, though now almost full of water and no longer worked.

On Dr. Lewis' farm, two miles north-west of Raleigh, is a gray, fine-grained gneiss which has been worked at intervals for foundations, curbing, flag-stone and general building purposes in Raleigh for many years. It works well in two directions; and an opening sixty by seventy-five feet has been made in a natural outcrop which is continuous for a quarter of a mile. It may be seen in one of the oldest buildings in Raleigh—Christ Church—in which it was used as sills and trimmings. No disintegration, discoloration, or other injurious effects of weathering are visible.

At Wyatt, on the Raleigh & Gaston railroad, on the property of L. R. Wyatt, a very pretty pink granite is found in outcrop, but not enough prospecting has been done to test its quality. Present indications are that there is only a limited quantity, but further

investigation should be made, as it is a good stone and is well located with reference to shipping facilities.

Near Rolesville, half a mile to a mile south of the village, and about fifteen miles north-east of Raleigh, and five miles east of the Seaboard Air-Line railroad, there is a gray biotite granite with pinkish feldspar, of fairly uniform texture and medium grain, exposed over several acres of area. No extensive quarrying has been done, but the few blocks of stone that have been gotten out for local use indicate good working quality for this granite. A sample block may be seen in the State Museum.

Two miles south-east of Rolesville, on the land of S. W. Terrell, are a number of exposures of granite which is said to be similar in general character to that at Rolesville.

GRANITE IN FRANKLIN COUNTY.

There are numerous outcrops of granite and syenite in this county, especially in the eastern portion about Cedar Rock, and a good specimen of pink-colored syenite from this locality is in the State Museum. Bare exposures of such rock, several acres in extent, may be found on the lands of W. J. King and others in the vicinity.

One mile south-east of Louisburg, on Col. Ruffin's place, a fine-grained pinkish stone is reported which is said to work well.

Two or three miles north-west of Louisburg a gray granite outcrops in the form of numerous large boulders. The color and texture of the stone appear to be uniform, and the grain medium to fine. It is said to work well, but no quarrying has been done.

THE COUNTY QUARRY at Louisburg is on the left bank of Tar river, and furnished the stone for the county jail. It is a uniform, light gray granite of fine texture. The surface stone used in the jail is rather friable and frequently streaked with quartz veins, but it has stood the weathering for twenty years without apparent injury.

On the FREEMAN'S MILL PLACE near the Wake-Franklin county line, about twelve miles west of Springhope, the present terminus of the Albemarle & Raleigh railroad, and twenty miles east of Raleigh, are several exposures of gray biotite granite of fine to medium grain and fairly uniform texture. The outcrops are to be

found on both sides of Moccasin creek, which is here the dividing line between Wake and Franklin counties; and the more promising points are sufficiently elevated above the creek to avoid trouble from water in quarrying. The stone appears to be free from injurious minerals, and a quarry will no doubt be opened up as soon as railroad transportation becomes available.

GRANITE IN GRANVILLE COUNTY.

A gray granite which works well is found in the vicinity of Oxford and eastward in numerous large boulders. Many of these have been split up for curbing, foundations, house trimmings and other local purposes, but no important ledges have been worked. It is of medium fine grain, light gray color, and quite compact, and would doubtless dress well in any of the usual styles of finish.

GRANITE IN WARREN COUNTY.

Warren presents natural outcrops of a light gray granite in several places, and a good typical specimen of it may be seen in the State Museum. Those of most importance from their location are to be found just north of Warren Plains, on the Raleigh & Gaston railroad, and at Warrenton. The latter place was worked in 1867-'68 for stone to build the county jail. The walls were plastered, however, and only the window sills left exposed. These show no perceptible change. It is a uniform fine-grained gray granite, and is exposed in several places on a gentle slope west of the town. The small grains or crystals of pyrite found scattering in it may cause it to stain slightly. By the aid of joints the stone used in the jail was quarried without blasting.

About one mile north of Warren Plains, on the land of Mr. W. J. Norwood, are several exposures of gray biotite granite of fine to medium grain, fairly uniform texture, and generally free from injurious minerals. The stone here has not been quarried sufficiently to indicate its working quality; and while the probabilities are in favor of this being satisfactory yet it can only be determined by actual tests.

About two miles north-west of Warren Plains is another outcrop of gray granite somewhat similar to the above, but of slightly

coarser texture. A number of millstones were gotten out at this place many years ago, and several incomplete millstones are still to be seen lying on the surface. The granite here appears to have good working qualities.

Other outcrops of good stone are found in different parts of the county but at a distance from railroads, and hence they are of little immediate importance.

STONE IN ANSON COUNTY.

A very pretty mottled porphyritic *granite* occurs near Lilesville on the Carolina Central railroad. It is quite firm and compact and takes a fine polish. The colors are mottled olive-green, pink and black, and it would give beautiful effects in ornamental work.

A dark, rich olive-green *norite*, nearly black, and locally known as "black granite," is found on Jones' creek in Anson county. It takes a high polish and is a valuable ornamental stone, as will be readily seen from the blocks exhibited in the State Museum. A stone of similar nature in every respect is found north-east of this in the western border of Richmond county on a hill just beside and about forty feet above the Carolina Central railroad. It has not been used as yet, except in the construction of piers of the railroad bridge across the Pee Dee river. It is very tough and compact and probably rather too difficult to work to permit of its being used for ordinary building purposes, but its principal field of usefulness would seem to be in decorative work.

STONE IN RICHMOND COUNTY.

Three and a half miles west of Rockingham, on the Carolina Central railroad, at Hitchcock's creek, is a coarsely porphyritic *granite*. The large feldspar crystals are slightly pink in color and contain some pyrites, which is also disseminated in small quantities throughout the rock mass—enough doubtless to produce serious discoloration from weathering in exterior work. Immense boulders and ledges of it are exposed on the hill-side and in the railroad cut near the foot of the hill. It is susceptible of a high polish and has a very handsome appearance—qualities which

highly recommend it for interior ornamentation. It was used to some extent in the piers of the railroad bridge across the Pee Dee river.

About four miles west of Rockingham and one-fourth of a mile from the railroad is a dark, fine-grained *norite*, locally known as "black granite," which was described above in speaking of a similar stone in Anson county.

GRANITE IN WILSON COUNTY.

A few miles south of Wilson, where the Wilmington & Weldon railroad crosses Contentnea creek, is a coarse, red, feldspathic granite of homogeneous texture, which outcrops on both sides of the creek and may be traced by natural exposures for a mile or more up stream. It splits readily and takes a good polish, and would doubtless prove valuable for ornamental if not for general building purposes. It has been used locally to a small extent, and was employed by the railroad company in the construction of bridge piers at Contentnea creek. It is broken up by a system of horizontal joints into beds three or four feet thick, and vertical joint-planes break these into large blocks. At one point on the creek the ledge rises forty feet above the water. Good specimens are in the building stone exhibit of the State Museum, and in the walls at the entrance to the Atlantic Coast-Line railroad office in Wilmington.

GRANITES IN EDGECOMBE COUNTY.

Two and a half miles above Toisnot, on the Wilmington & Weldon railroad, is a medium to coarse porphyritic granite of dark color, which has been used extensively for railroad construction, and as a curbing and building stone in Wilmington. It was also used in the foundations of the post-office building in Raleigh. In many respects it is an excellent building stone, but its working qualities are not very good.

Stone of much the same general character is found at Rocky Mount, but has been worked to only a slight extent.

THE PIEDMONT GRANITE BELT.

This division includes the granitic rocks of Gaston, Mecklenburg, Cabarrus, Iredell, Rowan, Davidson, Davie, Forsyth, Guilford and

Alamance counties; constituting Kerr's "Lower Laurentian" belt, and situated along the eastern border of the central "granites and gneisses" indicated in Plate VII of this report. Although not closely connected with this granite belt, the Mt. Airy quarry in Surry county, and the peculiar gneiss of Taylorsville, Alexander county, forming part of the same great central body of granites and gneisses, are considered under this head.

The quarries near Salisbury, Rowan county, and Mooresville, Iredell county, are the only ones now in operation in this belt. At Mooresville there are two quarries worked principally for monumental stone. Near Salisbury there are four companies at work (1892) turning out paving-blocks, curbing and macadam, but very little material for architectural purposes. No quarrying has been done in any of the other counties, except on a small scale and for purely local or special purposes. The properties of the stone in this belt are so variable that no attempt will be made at a general description.

STONE IN GASTON COUNTY.

There are only two places to be noticed in this county, and neither of these have been worked to any considerable extent. North-west of Gastonia, about two miles and a half, and about two miles south-east of Dallas, is *Peysour's quarry*, situated one mile above the point where the Chester & Lenoir railroad crosses Long creek. The granite here forms a hill or long ridge about forty feet above the creek, with extensive exposures along the top. A little stone has been taken out for monument bases and for trimmings for the court-house at Dallas. It is a rather fine-grained gray granite with a well-developed porphyritic character in places. The surface stone, which is all that has been worked, is rather friable and should be stripped off to a depth of four or five feet in quarrying.

C. L. HOPE'S QUARRY, three miles north-west of Bellemont, is in a medium to coarse-grained light gray granite with a slight pinkish tint. It is quite hard, of uniform color and texture, and a very desirable stone for general building purposes. It is exposed for some distance on both sides of a small stream, in a bluff about twenty feet high on one side and in a gentle hill-slope on the other.

Several places have been worked a little, and altogether there have been about two hundred feet of stone quarried here. One of these places is now being worked by a small force for foundations, sills and trimmings for the new building of St. Mary's College at Bellemont. It has also been used to some extent in Charlotte for similar purposes. It is found to split very well in two directions and fairly well in the third. The following is an analysis of the granite from this quarry:

ANALYSIS OF GRANITE, HOPE'S QUARRY, GASTON COUNTY.

SiO ₂	77.25
Al ₂ O ₃	8.18
Fe ₂ O ₃	8.17
MnO ₂	1.82
CaO.....	0.70
MgO.....	0.39
Na ₂ O.....	2.05
K ₂ O.....	1.22
Loss on ignition.....	0.01

STONE IN MECKLENBURG COUNTY.

In this county there are two quarries, of local importance.

THE CITY QUARRY AT CHARLOTTE, near the freight depot, has furnished considerable amounts of stone for paving and macadamizing the streets; but it is too variable in texture and color, and too much jointed for architectural purposes.

THE SMITH QUARRY, four miles south of Charlotte (property of W. M. Smith, of Charlotte) is in a fine-grained hornblende granite, and is opened in a low, flat place, near a small branch, about a quarter of a mile from the railroad; but outcrops are found on the hill-side nearer the railroad and above water. Years ago mill-stones were quarried here for use in the primitive ore-mills for the gold mines in this and adjoining counties. In recent years it has been used frequently in small quantities by the marble workers of Charlotte for monumental purposes; and several very pretty monuments of it may now be seen in the city cemetery. Small quantities have also been used for trimming, sills and other building purposes in Charlotte. The old court-house was furnished with

sills, steps and paving for porches from this quarry, and no indication of age is seen except in the wear of the pavement and steps. Some of the oldest business blocks have also more or less of this stone in their construction, but it shows no effects of weathering. It is quite hard and polishes well. The hornblende is mostly clustered into small groups of crystals, giving a speckled appearance to the polished surface. Blocks of any desired size seem to be obtainable. It is a beautiful stone and well adapted to monumental and decorative purposes, but its working qualities are not sufficiently good to permit of it being used as general building material.

The stone used in the main building of Davidson College was obtained mostly at the *Sloan mill place*, now owned by Z. A. Hovis, and situated about three and a half miles east of the College. It is a gray granite of coarse to medium-fine texture, with black mica distributed through the mass in small spots or specks. It is used in the foundations, steps and sills, and was obtained chiefly from boulders. The building was erected about 1860, and the stone has apparently suffered no injury from weathering.

Five miles south-west of Davidson College, on the *Lawson Potts place*, is a coarse white feldspathic granite, flecked with black mica. It has an extensive surface exposure and has been used to a small extent for foundations of buildings at Davidson College and Charlotte.

STONE IN CABARRUS COUNTY.

There is nothing approaching a quarry in this county, neither has there been any prospecting of importance. There are, however, outcrops of granite in many places. One of pink granite is found on the Mount Pleasant road, six miles east of Concord. It is a fine-grained, homogeneous stone of deep pink color, has very little mica and works readily. It will doubtless prove valuable as an ornamental stone. A good polished specimen is in the State Museum.

STONE IN IREDELL COUNTY.

Near Barium Springs, five miles south of Statesville, is a fine-grained dark granite, easily worked, which has been used considerably for bridge piers and other engineering work, and to a slight extent for sills and lintels in brick buildings.

At Mooresville there are three quarries, two for monumental stone, and one that has been worked to some extent for building material. There are good specimens of this stone in the State Museum.

J. N. BREED'S QUARRY, one and a half to two miles south-west of Mooresville, has been worked since 1886 for monumental stone. It is on Robert McNealy's land and is operated under a lease. The quarry was opened in 1886 and the work has been continued on a small scale to the present time (1892). It is a fine-grained, gray biotite granite, with occasional spots of coarser or darker material, which are caused by a larger proportion of black mica. These spots are avoided, however, with little waste. The quarry is in a bluff, at the foot of a small hill which rises fifteen to twenty feet higher than the present working. The heading or quarry face is about twenty-five feet high by forty feet long, and the work has advanced into the hill about forty feet. The stripping is about ten feet, but some of it is stone of fair quality. A portion of the present working is below the level of the branch, and is drained by a small steam pump. The stone is jointed into nearly horizontal layers three to eight feet thick, and these are broken into large blocks by other joints nearly vertical. Blocks twenty feet long and three by three feet in cross section were seen in the quarry, and much larger ones are obtainable. It works well, splitting with true faces and edges. Thus far the quarry has been worked only for monumental stone, and most of the output has been dressed in Charlotte and shipped to various parts of the State. Its great hardness renders its working rather expensive, but it takes an excellent polish and chiseled letters for ornamental carving stand out in beautiful contrast on a polished surface.

THE JOHNSON QUARRY* is one-fourth of a mile up the branch from the last, in the same ledge of stone, and is just being opened. Some of the stone has a more speckled appearance than that of Breed's quarry, owing to the more extensive segregation of the black mica, but no other important difference is observed, and this one is doubtless only superficial. But little stripping is encountered in this place and the prospect for economic quarrying

*Subsequently purchased by the Charlotte Granite Company.

here on a large scale is good. The quarry is about one-fourth of a mile from the Atlantic, Tennessee & Ohio railroad and a branch track can be run to it without serious expense. The following is an analysis of the granite from this quarry:

ANALYSIS OF GRANITE, JOHNSON QUARRY, MOORESVILLE.

SiO ₂	66.01
Al ₂ O ₃	17.44
Fe ₂ O ₃	5.62
MnO ₂	0.23
CaO	1.44
MgO.....	1.11
Na ₂ O	5.06
K ₂ O	3.16
Loss on ignition	none.

BIDDELL'S QUARRY is three miles east of Mooresville and was operated for a short while, a year ago (1891), for building stone, which was hauled on wagons to Mooresville and shipped to Pennsylvania markets. Three places were opened in the sloping hill-side; but in each the stone was found rather variable in color and intersected by numerous quartz veins. There has been no systematic work done, however, and scarcely more than the surface stone has been touched. The greater part of that exposed is of good gray color and medium to fine grain; and, except for occasional pinkish patches, segregations of black mica, and the quartz veins mentioned above, it is a very desirable stone. By careful selection these could all be avoided in stone for face-work without great loss. Any of the places worked would give a good quarry face with but little stripping. A hoisting engine, steam derricks and drills are on the grounds.

GRANITE IN ROWAN COUNTY.

The principal outcrops of granite in Rowan are found in the hills and ridge known as Dunn's mountain, and its southward continuation for a distance of ten miles. At many places nine and ten miles south of Salisbury, and three or four miles east of the North Carolina railroad, the stone outcrops in broad exposures of several acres extent, and has been worked in some of these places

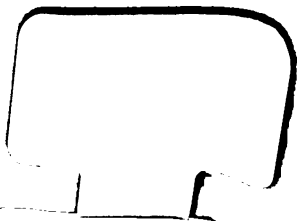
to a small extent for foundations, street work, and window and door sills in Concord and Salisbury. One of these places, ten miles south of Salisbury, is described as a very siliceous, white granite of fine grain and good working qualities. Another, nine miles south of Salisbury, is a pinkish feldspathic granite with a system of joints which aids very materially in quarrying. A dark quartzose granite, used in the Lutheran church at Concord, is found in the *Phillips quarry* in the same vicinity. In this region is also *Basinger's millstone quarry*, a coarse, compact quartzose granite which has been used somewhat extensively for millstones and in small quantities for building purposes.

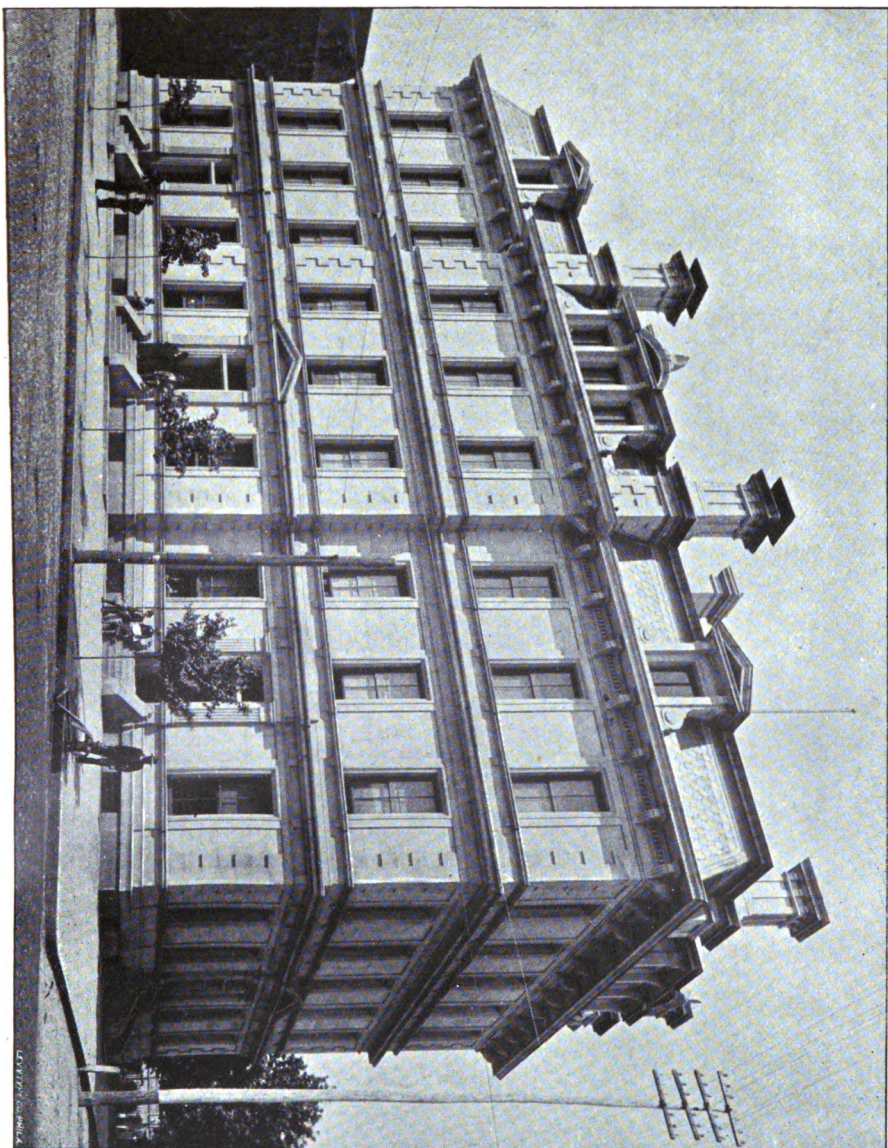
At all these places there are large outcrops, capable of furnishing immense quantities of stone without stripping. They were worked ten or twelve years ago to the extent of 5,000 to 30,000 cubic feet each; but have not been operated since, except to supply occasional small local demands.

The most important granite area in Rowan, and one of the most important in the State, is that mentioned above as the Dunn's mountain, and the adjoining ridge for two miles south. The Yadkin railroad, crossing this ridge just south of Dunn's mountain proper, has made it practicable to build switches and open quarries in almost any part of this region. Since the construction of this road four companies have been organized to work the granite in various localities; three of these are now (1892) operating quarries, and the fourth has just placed its machinery on the grounds.

With the exception of Dunn's mountain proper, all the stone of this great boss is of medium fine grain and light gray color. It is speckled with occasional small crystals of magnetite and pink feldspar; the latter in places merging into a uniform pinkish tint, as in the Kirk mountain quarry, described below. Also on Dunn's mountain the granite of the boulders which furnished the stone for the post-office building in Raleigh* (Plate IX) is of a light gray color with only a shade of pink; and at a short distance it resembles marble. But in the ledges, which outcrop extensively on the mountain, the stone is found to have a uniform light, but distinct

*The slight discoloration to be seen on the outer granite walls of this building is due to the use in its construction of large quantities of stone from surface boulders instead of from deeper ledges.





POST-OFFICE BUILDING, RALEIGH. DUNN MOUNTAIN GRANITE.

pinkish tint. Blocks of both colors from this locality are exhibited in the State Museum.

Notwithstanding these variations in the color of the stone at different places that in any single quarry is found to have a strikingly uniform color, texture and good working qualities. The boulders are said to invariably prove harder than the ledges, and the latter to improve in the ease with which they are worked on going down from the surface.

THE PINK GRANITE COMPANY owns Dunn's mountain proper and has prospected the north side of it along the foot of a steep bare ledge for a distance of one hundred and ten feet, and found the color and texture quite uniform. It is a light, flesh-colored pink granite with a grayish tint. Small crystals of magnetite are scattered through the mass. It is a beautiful stone and capable of a high polish. There are large areas of bare granite on the north, east and south sides of the mountain, the summit rising one hundred feet above the proposed quarry site. The "sap" or discolored surface rock rarely exceeds a foot in thickness and is of a gray color. The railroad crosses the ridge a mile south of this point and it is proposed to build the branch road around the side of the hill, which affords easy grade. An engine and other quarry machinery are on the grounds. The following analysis shows the general composition of the stone:

ANALYSIS OF GRANITE, PINK GRANITE CO.'S QUARRY, DUNN'S MOUNTAIN.

SiO ₂	75.14
Al ₂ O ₃	8.61
Fe ₂ O ₃	7.49
MnO ₂	trace.
CaO	0.93
MgO	0.04
Na ₂ O	5.82
K ₂ O	2.57
Loss by ignition	none.

THE HAMBLY QUARRY, property of E. B. C. Hamby, of Rockwell, Rowan county, is within a few hundred yards of the railroad and about a mile and a half south of Dunn's mountain. It is in the side of a considerable hill, and the stone is a light gray granite

thinly specked with red feldspar and with the black mica more or less aggregated into small bunches, giving the stone a speckled appearance. As yet only boulders, which are plentiful and large, have been worked here, but the stone obtained from them is good. These boulders are mostly above ground and are easily split by blasting. The discoloration in them from weathering penetrates deeper—sometimes 5 or 6 feet—than in the stone of the ledges. Paving-blocks and curbing are the principal products from this quarry. Stone from this and the adjoining quarry, described next below, was used in the foundations, steps, arches and trimmings of the Presbyterian church in Salisbury. A switch connects the quarry with the Yadkin railroad.

THE STONE MOUNTAIN GRANITE COMPANY'S QUARRY is not over two hundred yards from the last, and is on top of the hill now known as Stone mountain. This, too, has a switch from the railroad and works the same character of stone as the Hambly quarry. A slight difference is noticed in the more even dissemination of the black mica. It also contains a little more of the pink feldspar. Mill-stones were once quarried here and shipped to various parts of the State. The present working is for rubble in a ledge fifteen feet high and thirty feet face without a joint. The quarrymen say that the granite works well for dimension stone with the rift and grain and fairly well the "hard way," but that the rift is not so good as would be expected from the facility with which it splits with the grain. It has furnished stones for trimmings in the Methodist church at Reidsville, the Associate Reform Presbyterian church at Charlotte, and the Presbyterian church at Salisbury.

KIRK MOUNTAIN GRANITE COMPANY'S QUARRY is about three-quarters of a mile south of the last, on the same ridge, and about five miles south-east of Salisbury. At present the numerous large boulders on the surface are being worked off. The only difference between this stone and that of the Hambly and Stone mountain quarries consists in the pink feldspar being more evenly disseminated through the mass, giving a faint pinkish tint to the color. Its splitting qualities are excellent in all three directions, and long dimension stone is split almost to exact sizes with the greatest ease. About two hundred hands are employed here, and

the stone is hauled three-fourths of a mile along the ridge to the railroad. In connection with this the boulders at the foot of the hill, three-quarters of a mile west, are being worked, and the total product of both places is now used in curbing and street-paving under contract.

Other places on this ridge which present outcrops more or less favorably situated are one mile north of Dunn's mountain, known as the "Flat Rock" and the "New Discovery," and between Dunn's mountain and the Yadkin railroad, known as the "Buckley place."

GRANITE IN DAVIDSON COUNTY.

The only granite of importance in Davidson county is found in the vicinity of Lexington. It has nowhere been regularly worked, or extensively opened up, but it has been quarried as needed to supply an occasional local demand. The railroad culverts in the vicinity were built of stone obtained near Lexington. It is all of a dark gray color, inclining to blue, and is said to work well.

The granite used in the foundations, steps, porch pavement, and door and window sills of the court-house was quarried on the land of Joseph Conrad and Mrs. Fritts, one to one and a half miles north of Lexington. The building was erected about 1852, burned down in 1865, and afterward rebuilt on the same foundation. The stone is still good, and, with one or two exceptions, is not badly scaled or cracked. The steps and porch pavement show no wear.

"ORBICULAR GRANITE" IN DAVIE COUNTY.

On the Yadkin river, at the Coolomee farm, property of Frank Hairston, near Fork Church post-office, is a beautiful spotted stone which has been called "orbicular granite"; and which is thus described by Mr. Merrill:* "A very peculiar granite, and one which may prove of value for ornamental purposes, occurs at Coolomee, in Davie county. The stone is composed of radiating green augites in rounded masses an inch or more in diameter, imbedded in a white or pinkish ground mass of quartz and feldspar. On a pol-

*Stones for Building and Decoration, page 207.

ished surface the effect is quite unique." A beautiful specimen of this stone is on exhibit in the State Museum.

STONE IN FORSYTH COUNTY.

There are no quarries in Forsyth, but a few places that have received that appellation locally are worthy of brief mention.

Five miles south of Winston, on Mrs. Charles' property, is an exposure of granite of about an acre on a steep hill-side. The texture is coarse to medium fine and the color a light gray. These properties are quite uniform except for occasional streaks of black mica where the granite becomes gneissoid. The exposure extends from the foot of the hill to a height of about thirty feet, and some stone has been quarried here for curbing, sills, and other rough work in Winston and Salem.

Three miles east of Winston and a quarter of a mile south of the railroad, on the "Maston place," is a gray gneiss. It is of medium fine grain and quite uniform in texture and color. It splits well, especially with the rift and grain. The stone is bare in several places on the hill-side about fifty feet above the branch, and was worked some twenty years ago for railroad purposes to the extent of about 5,000 cubic feet. Tool-prints of the old work are still visible on blocks of stone at the quarry.

STONE IN GUILFORD COUNTY.

Guilford has no quarries, but there are several places opened for railroad construction which may be of some value.

Near Jamestown are several places, two to three miles south-east, where granite has been obtained for local purposes.

Near Brown Summit, a mile and a half south of the station and a half mile from the railroad, is a medium fine homogeneous stone which splits readily and has been used considerably in local work.

Three miles north of Friendship, on the Northwestern North Carolina railroad, is a medium fine to coarse-grained granite which has been used only in railroad work.

About one mile south-west of Summerfield, on the Cape Fear & Yadkin Valley railway is an outcrop of gray biotite granite, of

medium grain and fairly uniform texture, which was worked to a small extent in 1891.

GRANITE IN ALAMANCE COUNTY.

A white granite, closely resembling marble, and of fine grain and good working qualities, is found one mile north of Burlington on Christian Iseley's place. It has been used very little, but may be seen in Mr. Iseley's house, where it is used for window and door sills. No natural outcrops are visible and nothing can be said of the extent of this stone. Another outcrop of granite is to be seen just south of Burlington.

At several places about four miles north of Burlington small quantities of granite have been quarried for window and door sills in the factories of that vicinity, but no regular quarries are worked. The stone is usually a rather coarse-grained gray granite, and generally quite uniform in texture and color, with good working qualities.

GRANITE IN SURRY COUNTY.

THE MT. AIRY QUARRY, the only one to be considered in this county, is two miles east of the town of Mt. Airy in a solid hill of granite which rises one hundred and twenty-eight feet above the railroad at its base. An area of about forty acres of rock is bare on the hill-side, and no extensive joints have yet been found in the stone. It is a medium fine-grained light gray granite, with no visible iron or other injurious accessories. The quarry is operated by the Mt. Airy Granite Company, of Greensboro. Work was begun in June, 1890, and has been steadily continued since, with an average capacity of about three hundred cubic feet per day. This is shipped rough and dressed for building purposes to Washington, Baltimore, Philadelphia and other Pennsylvania markets, and some to Southern markets. About 250,000 cubic feet of stone have been shipped to date (August, 1892). The composition of this granite is indicated by the following analysis, which shows also the absence of injurious ingredients:

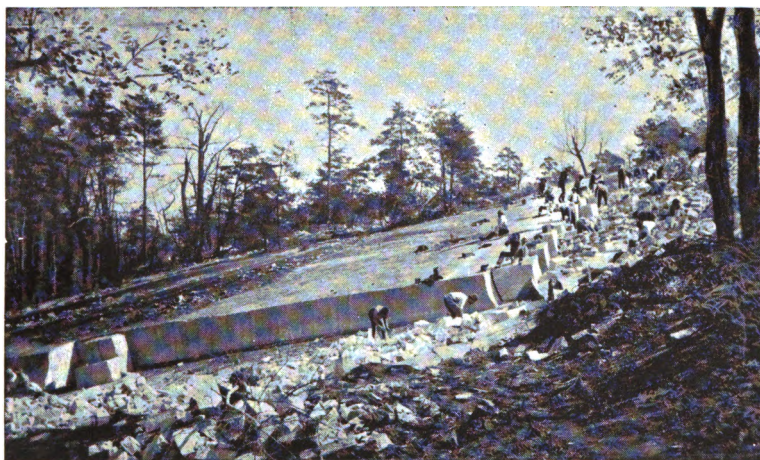
ANALYSIS OF GRANITE, MT. AIRY QUARRY.

SiO ₂	70.70
Al ₂ O ₃	16.50
Fe ₂ O ₃	2.34
FeS ₂	0.093
CaO	2.96
MgO.....	0.29
K ₂ O.....	2.45
Na ₂ O.....	4.56

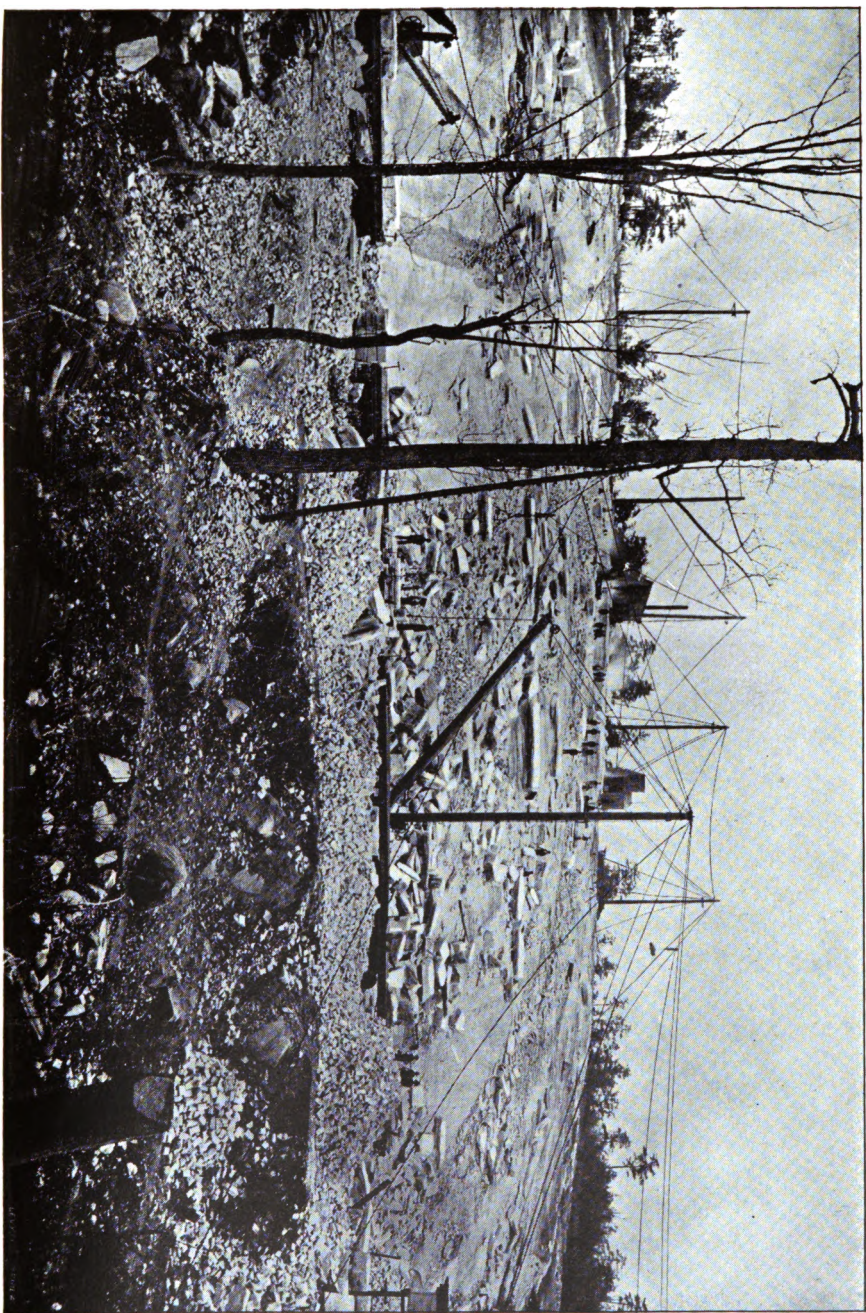
It has an excellent rift, and splits equally well with or across the grain, each being about one-third harder than the rift. The method of quarrying at the time of the visit, owing to the massive, unjointed character of the rock, was quite unique, and well illustrates the excellent working quality of the stone. No heading or quarry face was used, but work is carried on over a considerable area of bare stone on the hill slope. The method consists essentially of a hole drilled perpendicular to the surface to a depth of six to twelve feet, according to the thickness of stone desired, and then fired by a succession of light blasts, gradually increasing the charge.

The break thus caused begins on a plane almost parallel to the surface, but gradually inclines upward with successive blasts until it finally breaks out on the surface at a distance of one hundred and fifty to two hundred feet from the center. In practice these breaks are rarely forced out by blasting. The blasting is repeated till the shell is judged, from experience, to be free almost to the edges; it is then left to break loose from the force of the strains already induced, aided by successive expansions and contractions by day and night. One or two days usually suffice to complete the break and the stone is ready to be split into any desired shapes by wedges. This is done by working inward from the margin, gradually approaching the thickest portion at the center.

Plate X shows the character of the stone and how these great "shells" are worked up; Plate XI shows the general quarry surface and the arrangement of steam derricks and the trolley system of wire ropes for moving the stone from various parts of the hill-side to the platform at the foot of the hill, where it is loaded on the cars of the Cape Fear & Yadkin Valley railway. It will be seen that the thickness gradually diminishes from the center of the loosened disk to the circumference, but in dimension stone of ordinary sizes



MOUNT AIRY GRANITE QUARRY. WORKING UP THE "SHELL."



MOUNT AIRY GRANITE QUARRY.

this variation can scarcely be detected. The increase in thickness is usually one-half to three-quarters of an inch or less to the foot, and by making the longest dimension at right angles to the radius of the disk a minimum variation is secured.

Almost the only waste in this method is at the thin edges, and the amount is very small compared with that of ordinary methods of quarrying. The stone is gathered up from various parts of the quarry and loaded on the cars by a set of tackle blocks mounted on a trolley. The largest blocks shipped weighed seventeen tons, but obviously any practicable sizes are obtainable, the limits being regulated only by the limits of the capacity for handling and transporting. There is no stripping and no loss from sap, the thickness of discolored stone not being more than an inch, and frequently less. A typical block of this granite is exhibited in the State Museum.

STONE IN ALEXANDER COUNTY.

A talcose gneiss is found at Taylorsville and has been used in the construction of a two-story building at that place. In the quarry the material is quite soft and is easily worked into any shape or size with old axes and saws, but on exposure it hardens considerably and makes a very substantial wall. The color is a brownish-red very similar to the brownstone of the Triassic region, but being schistose it is somewhat streaked. The building erected two years ago is perfectly intact and the chimneys of the same material built twenty-five years ago show no serious disintegration. It is considered fire-proof and locally is much used for hearths and fire-place linings. The building referred to was built of stone quarried on R. Z. Linney's land within a half mile of the town of Taylorsville.

MARBLE AND OTHER FORMS OF LIMESTONE.

Limestone occurs in North Carolina at a number of different localities and in a variety of forms. In the south-eastern counties it is found in many places in an uncompacted condition resembling marl; in many other places it occurs in the form commonly known as shell-rock, as may be seen at a number of points on the

North-east Cape Fear, Trent and other rivers. At still other places it occurs in the form of a fairly compact, fine-grained limestone rock, which contains, scattered through it here and there, more or less distinctly preserved shells, and this form, frequently in the same locality, changes to a typical shell-rock.

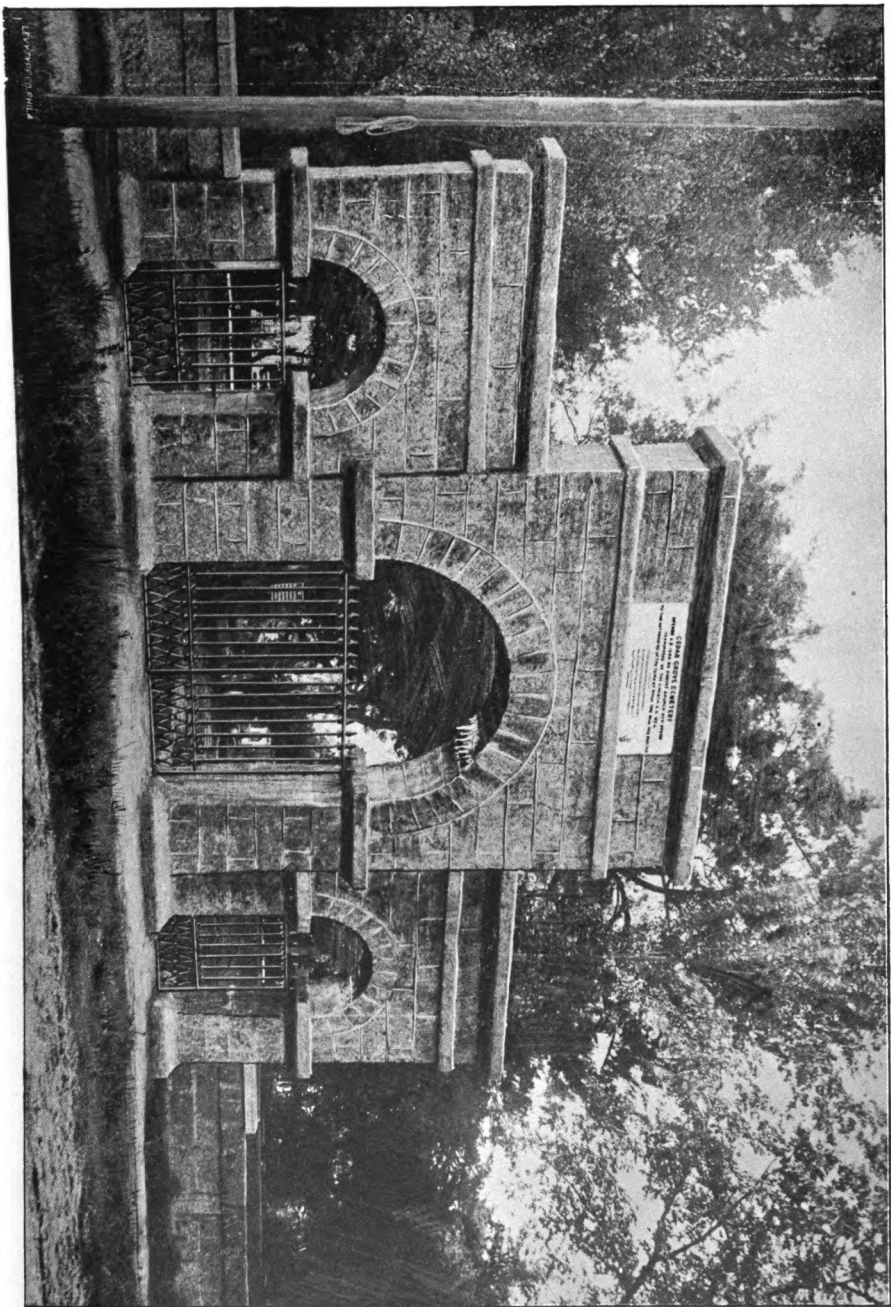
Shell limestone abounds in nearly horizontal beds in the coastal plain formations of several eastern counties, but it has been very little used as yet. It is quarried with great facility and hardens sufficiently on exposure to the air to become a very serviceable and durable stone for rough, massive work.

A shell-rock, which in places is a fairly compact limestone, and has been extensively used for harbor improvements about Wilmington, is found on the North-east Cape Fear river opposite Rocky Point and owned by Messrs. French Brothers. It is overlaid by one to five feet of soil and marl and has been worked over an area of a number of acres. This stone is also used for burning an excellent grade of agricultural lime, and in places contains small nodules of phosphate of lime.

THE TRENT RIVER SHELL-ROCK, located on Trent river, in Craven county, is a somewhat open shell-rock, used locally for rough building purposes and foundation walls. An excellent illustration of the possibilities of this stone is seen in the walls and arched gate-way of the city cemetery at Newbern, which are built of it (Plate XII). The stone is composed of medium to large size shells, with an admixture of sand, and the whole cemented together with carbonate of lime. It is a durable material, and I see no reason why it should not be used in the walls of larger buildings. It can be quarried and brought to Newbern on flats.

The shell-rock at this place, and that which occurs at Castle Haynes, Rocky Point, and other places on the river, can be used to considerable advantage in macadamizing the streets and public roads in these eastern counties, as may be seen in some of the streets of Newbern and Goldsboro paved in this way.

There are several localities in the midland and piedmont counties where there are limited deposits of a semi-crystalline limestone,—notably, those near Germantown, along the limestone belt which passes through Catawba, Lincoln and Gaston counties, and at



SHELL ROCK ARCH. ENTRANCE TO CEMETERY, NEWBERNE.

Turkey Cove, McDowell county. The limestone at this latter place, like that which occurs in the south-western counties of the State, may be properly considered a marble.

THE TURKEY COVE MARBLE DEPOSIT.

This body of marble, ten miles north of Marion, McDowell county, has been examined over an area of several hundred acres and has a thickness of more than twelve hundred feet. The beds dip at an angle of about 45° in a south-easterly direction into the north slope of Graveyard mountain. The marble is a fine-grained, compact dolomite, the color being usually nearly white, though in places it is distinctly blue, and a part of this blue marble is somewhat mottled. The general composition of the stone is shown by the following analyses:

ANALYSES OF MARBLE, TURKEY COVE, McDOWELL COUNTY.

	*WHITE MARBLE.	†BLUE MARBLE.
Silica (SiO_2)	.60	1.40
Oxides of iron and aluminum	.70	.70
Lime (CaO)	30.29	29.23
Magnesia (MgO)	21.22	19.58

These analyses show the stone to be a dolomite marble, containing, in the case of the white marble, 54.10 per cent. of carbonate of lime (CaCO_3), and 44.56 per cent. of the carbonate of magnesia (MgCO_3). The silica (SiO_2) and the oxide of iron (Fe_2O_3) are present in quantities too small to deserve further consideration. In a few specimens, however, the percentage of silica was found to be somewhat larger. A considerable portion of the stone has been seamed and broken in connection with the dynamic changes which have occurred in the geologic history of this region, and this has greatly decreased its value as a building or ornamental stone. But the purity of the stone and its freedom from injurious ingredients will permit of this broken portion being extensively used in the manufacture of lime and cement. A large portion of the marble, as shown by the drill borings conducted under the

*Analysis by F. P. Venable, from diamond drill borings, made by N. C. Geological Survey.

†Analysis by W. B. Phillips, Bull. 1, N. C. Geological Survey, 1893, p. 233.

supervision of the Survey, is generally free from these fractures and gashes, and is well adapted for use as a building or ornamental stone.

THE MARBLES IN SWAIN AND CHEROKEE COUNTIES.

There are considerable beds of marble occurring in Cherokee county and in that part of Swain county along the Nantahala river east of the Red Marble gap, and during the past few years these have attracted considerable attention.

The Nantahala marbles are exposed along the steep slopes of the mountain gorge on both sides of the Nantahala river, both above and below Hewitt station on the Western North Carolina railroad. The marble varies in color from nearly white to pink or flesh color and a deep bluish-gray. It is fine-grained and compact, and has been quarried to a limited extent. Two companies have been organized for the purpose of working these deposits on a larger scale.

In Cherokee county there are two or more belts of marble which appear in the south-western part of the county and extend in a general north-easterly course by way of Murphy and up the Valley river to the Red Marble gap; another parallel belt lying to the east crosses the Hiwassee river near Brasstown.

THE CULBERSON QUARRY, on the Marietta & North Georgia railroad, 11 or 12 miles south-west of Murphy, and the KINSEY QUARRY on the same railroad, five miles south-west of Murphy, have both been opened up during the past two years (1891-'92) on one of these marble belts. The stone at both these quarries is of a light gray color of fairly fine-grained and uniform texture. Its composition is shown by the following analyses, No. 1 being made from a sample from the Kinsey quarry, and No. 2 from a sample taken at the Culberson quarry:

ANALYSES OF MARBLE: KINSEY QUARRY (1), AND CULBERSON QUARRY (2).

	(1)	(2)
Silica	2.93	1.20
Oxides of iron and aluminum.....	1.17	.82
Lime (CaO)	49.83	52.90
Magnesia (MgO).....	3.61	1.91

The marble of these belts outcrops at a number of places between the Kinsey quarry and Murphy, and between Murphy and Red Marble gap, its color and general characteristics varying at different places. At the two following points, as shown by the analyses given below, it is dolomitic in composition:

At the HAYS PLACE, near Tomotla station on the Western North Carolina railroad, $5\frac{1}{2}$ miles north-east of Murphy, the marble is nearly white in color, but too much broken to be available as a building or monumental stone.

At the HICKERSON PLACE, $14\frac{1}{2}$ miles north-east of Murphy, and near Andrews station on the Western North Carolina railroad, the marble is nearly white in color, fine-grained, and is of a fairly uniform texture. It has been bored into with a drill at several different places, and was found to be sufficiently solid and free from breaks and gashes to make it well suited for architectural purposes. And quarry developments may be expected here in the near future. The composition of the marble at this point and at the Hays place is shown by the following analyses:

ANALYSES OF MARBLE: HAYS PLACE (1), AND HICKERSON PLACE (2).

	(1)	(2)
Silica .....	.92	1.58
Oxides of iron and aluminum.....	1.20	1.90
Lime (CaO)	32.80	32.42
Magnesia (MgO).....	15.43	19.58

Near Andrews station occurs a peculiar form of checked marble bluish-gray and white in color, the extent of which is unknown. A sample of it may be seen in the State Museum.

The outcrop of marble in the eastern part of Cherokee county, near Brasstown, is worthy of further examination. The stone is nearly white in color, of fairly uniform texture, and appears to be fairly free from breaks and gashes.

OTHER ORNAMENTAL AND BUILDING STONE.

A few notes are here appended on slate, serpentine, quartz-porphry, quartzite and soapstone.

SLATES.

Very little has been said or known of North Carolina slates, and no systematic examination of them, from an economic point

of view, has been made. The following information was gathered by personal investigation of a few localities.

IN CHATHAM COUNTY, three miles north-west of Egypt, on Robert Burns' place, is a compact blue clay slate, exposed for a hundred yards in a gully on the hill-side. It is quite fissile, sheets of the thickness of ordinary roofing slate and eighteen inches square having been split out near the surface. No prospecting of any consequence has been done, and no confident assertion as to its value can be made. The cleavage plane dips 75° north 20° west.

Three miles west of Goldston, on Hugh Womble's place, is a slate of the same nature, but with cleavage less highly developed. It is used for chimneys and foundations in the surrounding country on account of the ease with which it splits into slabs and blocks. It would doubtless prove suitable for flagging, mantels, and other work requiring slabs, though hardly fissile enough for roofing.

On Rocky river, south-west of Pittsboro, and four miles above its junction with Deep river, near the mouth of Bear creek, is a hard blue siliceous slate, which splits well into large sheets on the outcrop, though not thin enough for roofing. The outcrop was traced up the branch for three-fourths of a mile, and numerous broad sheets were seen, which had been split off by the action of the water. The cleavage planes dip 75° south 13° east. It is the property of the Deep River Navigation Company.

In the southern edge of the county, near Fair Haven, is a hard siliceous slate of steel gray to almost black color, and having a clear, metallic ring on being struck with a hammer. A shallow ditch has been sunk across the outcrop, and blocks from near the surface are easily split into large thin sheets, well adapted to roofing purposes. The outcrop can be traced for a considerable distance on the property of George Snow, of Raleigh, and that of C. H. Womble, of Fair Haven.

IN STANLY COUNTY, six miles east of Albemarle, is a dark bluish roofing slate, which is quite compact and siliceous and has a clear, metallic ring. It splits well into sheets with perfect planes, and small quantities from the prospect openings have been shaped into

roofing of small and medium sizes. Large specimens of this slate are in the State Museum.

Two openings about one-fourth of a mile apart along the outcrop in the direction of the strike, and ten or twelve feet deep, have been made for testing its quality. It was found to work equally well in the two places, with small waste, notwithstanding the fact of its being near the surface. The dip of the cleavage in one opening is 77° north 26° west, in the other 67° north 46° west. The smallest blocks could be almost entirely utilized for the smaller sizes of roofing, while the larger sizes could apparently be obtained in considerable quantities. Sheets measuring two by three feet were taken from both openings.

SERPENTINE.

IN BUNCOMBE COUNTY, near Alexander station on the Western North Carolina railroad, are found numerous masses of mottled greenish-yellow to dark green serpentine. Small polished specimens from this locality may be seen in the State Museum. A belt of disconnected outcrops has been traced from near Leicester on New Found creek north-eastward across the French Broad river about a mile above Alexander, and up Reams creek nearly to Weaverville. Many of these masses are large and the quality of the stone is undoubtedly equal in every particular to that of Pennsylvania and Maryland, which is extensively used for building. Although soft and easily worked, serpentine is quite tough and resists weathering well. These properties, as well as the unique color effects, are well illustrated in several churches in Philadelphia and Baltimore which are constructed entirely of this stone. For interior ornamental work polished serpentine is a stone of great beauty and very desirable where not subjected to wear. No North Carolina serpentine has yet been quarried for building purposes, but it will doubtless come into demand in the near future.

IN MADISON COUNTY, on Paint Fork of Ivy river and in the continuation of the same belt, are numerous outcrops of serpentine which are doubtless as good as that in Buncombe county, though now too far from the railroads to be of any immediate importance.

Good specimens of serpentine are in the State Museum from

CALDWELL COUNTY, near Patterson. It is a dark rich green variety, almost black and marked by very small veins of silky chrysotile. It takes a fine polish and is well adapted to interior decorative work.

Greenish-gray serpentine, mottled with greenish and whitish chrysotile, occurs in the Baker mine, in this county, along with the coarse, fibrous variety known as picrolite.

A pale green, massive variety, mottled with yellowish veins and patches and irregular seams and grains of magnetite, occurs in WAKE COUNTY fourteen miles north-west of Raleigh, on Barton creek, in a ledge which outcrops for several hundred yards. Several specimens of this stone have been placed in the State Museum.

QUARTZ-PORPHYRY ("LEOPARDITE").

In Mecklenburg county, a mile and a half east of Charlotte, there occurs a quartz-porphyry with very peculiar manganese markings in a vertical dike ten to fifteen feet thick and traceable on the surfaces for half a mile. Mr. Merrill* describes this stone as "a very light-colored, almost white, quartz-porphyry, which is penetrated by long parallel streaks of a dead black color. These are so arranged that, when cut across, the surface appears studded thickly with roundish and very irregular black points of all sizes up to half an inch in diameter. Cut parallel with the direction of the pencils, the surface is streaked with black lines, which sometimes assume beautiful fern-like or dendritic forms.

"The rock is intensely hard, tough and without definite rift. It can therefore be worked only at great cost and is not regularly quarried."

The peculiar marking is said to decrease and finally disappear as the dike is traced northward. The stone takes a good polish and could be used with beautiful effect in inlaid work, but it is too brittle for carving. Several rough and polished specimens of this stone, and a small carved figure of a leopard, are exhibited in the State Museum.

QUARTZITE.

Near Mooresville, Iredell county, a very peculiar mottled quartzite is found. It is of a deep brownish-red color, streaked and spotted

*Stones for Building and Decoration, pages 220 and 221.

with white, and gives a very pleasing effect on polished surfaces. The great difficulty of working it into ordinary dimension stones would limit its application, but for some ornamental purposes it would seem to be very desirable.

SOAPSTONE.

Talcose rocks of the ordinary gray and bluish varieties, the only kinds used for any sort of building purposes, are found abundantly in the crystalline rocks of many counties of the State. They have been used in most of these regions for fire-places, chimneys, foundations of wooden houses and tombstones, but have nowhere been regularly quarried. Several of these places were visited, but not enough work had been done to show the quantity or quality of the stone at many of them. Hence little more than an incomplete list of localities can be given here. It is everywhere worked with axes and saws, and the ease with which it is cut is doubtless the chief reason for its very general local use.

The following are some of the localities where ordinary soapstone has been noted: Near Burlington, Alamance county; in Alleghany county, twelve miles north-east of Sparta, near Enniss post-office; on the eastern flank of Elk ridge, six to eight miles south-west of Jefferson, Ashe county—once extensively used by the Ore Knob Copper Company for furnace linings; in Watauga county, on the southern slope of Elk Knob and also near Cook's gap; in Guilford county, four miles from Greensboro, near Jamestown. The peculiar talcose gneiss of Taylorsville, Alexander county, is described above (page 95).

LIST OF SPECIMENS OF BUILDING AND ORNAMENTAL STONE IN THE GEOLOGICAL COLLECTION OF THE STATE MUSEUM AT RALEIGH.

The following is a list of the specimens of building and ornamental stone now in the geological collection of the State Museum at Raleigh. The majority of these specimens are in the form of eight-inch cubes, which have one face polished and other faces dressed in different styles to show the working qualities of the stone. The collection is by no means complete, and it is desired to add to it specimens from all portions of the State, where building and ornamental stone occurs and which are not already represented. Persons who are willing to add specimens from other localities are invited to correspond concerning the matter with the State Geologist at Raleigh. All specimens sent to the Museum in the rough should be in sizes not less than ten inches cube. In the list given below the names of the county and locality and of the donor are given, when these are known:

SANDSTONE—Anson county.

Color light brown; grain fine.

SANDSTONE—Moore county.

Color chocolate-brown; grain fine.

SANDSTONE—Moore county.

Color chocolate-brown; grain fine.

SANDSTONE—Moore county.

Color light gray; grain medium fine.

SANDSTONE—Sanford, Moore county.

Color brownish-gray; grain medium fine.

SANDSTONE—Rackle & Lawrence quarry; Sanford, Moore county.

Color light brown; grain fine.

SANDSTONE—Rackle & Lawrence quarry (J. M. Wicker); Sanford, Moore county.

Color medium brown; grain medium.

SANDSTONE—Co-operative Brownstone Company's quarry; Sanford, Moore county.

Color light brown; grain fine.

SANDSTONE—Carolina Brownstone Company's quarry; Sanford, Moore county.

Color chocolate; grain fine.

SANDSTONE—Gulf, Chatham county.

Color light gray; grain medium.

- SANDSTONE—Gulf, Chatham county.
Color yellowish-gray; grain medium.
- SANDSTONE—Gulf, Chatham county.
Color yellowish; grain coarse.
- SANDSTONE—Taylor's quarry; Chatham county.
Color light brown; grain fine.
- SANDSTONE—Phil. Taylor's quarry; Chatham county.
Color brown; grain medium.
- SANDSTONE—Egypt, Chatham county.
Color gray-brown; grain medium fine.
- SANDSTONE—Duke's quarry; Durham, Durham county.
Color light brownish-gray; grain medium fine.
- SANDSTONE—Brassfield (?); Durham county.
Color light brown; grain fine.
- GRANITE—Warrenton (?), Warren county.
Color very light gray; grain fine.
- GRANITE, PORPHYRITIC—Lilesville, Anson county.
Color mottled pink, olive green and black; grain coarse crystalline.
- GRANITE, BIOTITE—Rolesville, Wake county.
Color grayish-pink or flesh; grain medium.
- GRANITE—Contentnea creek, Wilson county; P. Linehan.
Color red; grain coarse.
- GRANITE—Cabarrus county.
Color pink; grain fine.
- GRANITE, BIOTITE—Mooresville, Iredell county.
Color light gray; grain fine.
- GRANITE, BIOTITE—Mooresville, Iredell county.
Color steel gray; grain fine.
- GRANITE—Dunn's mountain, Rowan county; John L. Boyden.
Color light gray; grain medium fine.
- GRANITE—Dunn's mountain, Rowan county; John L. Boyden.
Color light pink; grain medium fine.
- GRANITE "ORBICULAR"—Coolomee, Davie county; Frank Hairston.
Color dark green spotted with white.
- GRANITE, BIOTITE—Mount Airy Granite Co., Mount Airy, Surry county.
Color light gray; grain medium.
- SYENITE—Cedar Rock, Franklin county.
Color pink; grain medium fine.
- GRANITE, GNEISS—Greystone, Vance county; J. E. Staggs.
Color light gray; grain medium fine.
- GNEISS—Hendersonville, Henderson county; W. B. Troy.
Color light gray; grain fine, compact laminated.
- GNEISS—Alexander, Buncombe county; R. B. Vance.
Color dark gray; grain fine.
- "GRANITE," NORITE—Lilesville, Anson county.
Color black; grain fine.

- "GRANITE," NORITE—Lilesville, Anson county; W. H. Battle.
Color dark olive-green, nearly black; grain fine.
- SERPENTINE—Alexander, Buncombe county; Jas. Foster.
Color mottled greenish-yellow (small specimen).
- SERPENTINE—Patterson, Caldwell county.
Color dark green, nearly black.
- SERPENTINE—Barton's creek, Wake county; Sol. Allen.
Color light green and yellowish, mottled; texture compact.
- SERPENTINE—Barton's creek, Wake county; Jesse Adams.
Color mottled green and white.
- QUARTZ-PORPHYRY, "LEOPARDITE"—Charlotte, Mecklenburg county.
Color spotted, black, on white ground; grain fine, dense.
- QUARTZITE—Mooresville, Iredell county.
Color brownish-red, white spotted.
- SHELL-ROCK—Trent river, Craven county.
Coarse open grain, of shells cemented.
- SOAPSTONE—Kinsey quarry; Kinsey, Cherokee county; A. Kinsey.
Color light bluish-gray.
- SOAPSTONE—Iredell county.
Color steel gray.
- MARBLE—Andrews' station, Cherokee county; A. B. Andrews.
Color fine steel gray; grain fine uniform.
- MARBLE—Near Valleytown, Cherokee county.
Color dark and whitish blue gray checked—unique.
- MARBLE—Murphy, Cherokee county; Wm. Beale.
Color pink, gray.
- MARBLE—Rickard & Hewitt's quarry; Hewitt, Swain county.
Color pink.

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